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ELECTRICAL REPUTATION TO-DAY AND IN THE PAST.

In the period of electrical development when the direct current monopolized the field, the slightest advance was heralded far and wide and reputations were made on what at the present day would be considered very slight achievements. During the past four years there have been many developments in alternating current systems and apparatus far surpassing in importance anything in the period referred to, and which have attracted but little general attention. While the work of Steinmetz, Scott, Lamme, Leblanc and a few others is appreciated at its real worth in the upper ranks of electrical engineering, the designer of an odd shape of direct-current dynamo field in the pioneer days would have received greater general credit. There are in addition a number of others whose names are only known to a limited few, but who have perhaps been greater factors in the art than almost any one of a score or more whose names in the 80's were known to every electrician. A number of reasons may be assigned for this condition, but the principal one is undoubtedly the greater difficulty found in understanding alternating current phenomena by those who have not made a systematic study of the subject, thus limiting greatly the number able to follow the details of current advances. Moreover, but few of the advances have had the character of discoveries, being matters of current development by able and highly instructed technical men, who as members of engineering staffs have little opportunity—and probably slight desire—to come before the public eye. The condition to which we refer is, however, by no means peculiar to the electrical field. The name of Hero of Alexander is immortal, but who knows the name of the designer of the machinery of any one of the recent ocean leviathans?

ELECTRICAL INSTRUCTION.

Elsewhere in this issue we print an article entitled "A Chapter on Electrical Instruction," which is interesting as an illustration of the tendency of some minds toward substituting mere personal speculations—we were about to say, whims—for the tenets of a science resting upon the authority of great minds and upheld by the scientific experience of generations. Mr. Tyler would apparently substitute for modern ideas the fossilized conception of electrification, and goes so far as to suggest that the word "ohm" be divorced from its present usage and applied to designate the unit of "The persistence of matter to stay unelectrified!" He approves highly the shop-slang term "continuous dynamo" for continuous-current dynamo, and would doubtless also approve the term "pulsating dynamo," notwithstanding its ambiguity. It is interesting to speculate in turn on the effect produced on the mind of the practical man instructed in electrical science according to the system described. An electrician knowing the dissimilar applications in the art of, say, ebonite and copper, would naturally be puzzled when told that a distinction between conductors and non-conductors is unwarranted, and still more mystified if, in asking for the reason, he were informed that "there are no substances that cannot be electrified, so there are no non-conductors." Knowing also that a part cannot be as great as a whole, we can imagine his state of mind when informed that the word current is altogether superfluous—that the result of voltage is not quantitative but qualitative; that is, that the current of half an ampere for a single incandescent lamp differs in quality but not in quantity from the current for a thousand lamps. The query will doubtless occur to the reader, From what last-century source did Mr. Tyler derive his queer collection of electrical conceits?

THE STORAGE BATTERY.

The storage battery after a long and tedious struggle in its early years which at times seemed almost hopeless, has now gained recognition among engineers in this country as an unquestionably useful and sufficiently practical piece of apparatus to justify its employment wherever conditions may indicate. While it has been in successful use abroad for a number of years, and in this country for a few years, it may, however, still be considered far from an approximation to an ideal or to the theoretically perfect cell, and in this respect it differs greatly from the dynamo and transformer, in which the copper and iron are utilized to very nearly their maximum possible extent, leaving little room for improvement in that respect. In the lead accumulator, on the other hand, the active materials are very far from being utilized to their full extent, as the output of most cells per pound of material is still far below the calculated capacity, and the amount of chemically inactive material which serves merely as a conductor is generally far in excess of that required for conducting purposes. Moreover, it has the very serious fault that if discharged quickly, the output diminishes greatly and the life is affected.

Notwithstanding the great amount of study which has been devoted to the development of the lead storage battery, we believe that sufficient attention has not been given to a certain feature which, though pointed out by some writers, does not yet seem to have been fully appreciated. On discharge, the active material combines with the acid in the electrolyte, but it can do so only with that small amount of the acid which is contained in the molecular layer of the liquid in direct contact with the solid active material. This leaves a layer of diluted acid, or possibly even practically pure water, in contact with the active material. For the action to continue, this dilute acid or water must get away from the active material, and fresh acid must take its place. But the only forces acting to accomplish this are those due to diffusion and to the slight difference in specific gravity between the diluted acid and the fresh, to which possibly may be added the effect of a minute difference in temperature. But these forces are extremely small, and therefore the replacing of the layer of diluted acid by fresh acid is a very slow process, especially when the necessary flow of liquid in two opposite directions must take place through fine, nearly molecular pores. It is this slow diffusion which is the cause of many of the objectionable features of the present accumulators. If the electrolyte in direct contact with the active material could, after doing its work, get away faster and allow fresh acid to take its place, the output at the more rapid rates would no doubt be greatly increased and the plates rendered less liable to those injuries which are due to a depleted acid solution next to the active material. The importance of this was shown in some tests made a few years ago by one who appreciated the importance of this feature. The solution was circulated very rapidly by mechanical means, and about three times the normal output was thereby obtained with the same current. Presumably this was for rapid discharges, at which the output is considerably below that with very small currents.

As it is always well to have an ideal to strive for, even though it can only be approximated to, we would suggest that the theoretically perfect lead storage battery seems to be one in which no diffusion at all is necessary; or, as a recent writer stated it, one in which each molecule of active material is surrounded by as much acid as is necessary to discharge that molecule—in other words, a plate which possesses molecular porosity. Each of these molecules or small masses should be attached to the lug by means of no more conducting material than is necessary to lead off the current from that molecule, without undue resistance loss. The active material and its conductor should be so arranged that, besides serving the electrical purposes, they also supply the necessary mechanical strength. A practical approximation to this ideal would seem to be a Planté plate with a surface like fur or a brush, or else like a currycomb, the spaces between the little threads or sheets of active material being so proportioned that they contain the necessary amount of acid without requiring more than a minute amount of diffusion. The layers of active material would be quite thin and the lead conductor inside of each thread no larger than just enough to conduct the current. The backbone of the plate would increase in thickness toward the lug. When more attention is given to this question of diffusion, we believe that the lead storage battery will be much more satisfactory, will give less trouble, will last longer, and will maintain its output at more rapid rates.

AN ELECTROMAGNETIC EXPLANATION OF INERTIA.

An article on "An Explanation of Inertia," by Prof. R. A. Fessenden, which appeared in these columns last week, brought forward a subject of much intrinsic interest. It has been known for some time that a charged or electrified body resists having its motion varied, by reason of the magnetic disturbance which such variation effects, and which pulls upon the electric charge in such a manner as to oppose the change. This is a purely electromagnetic phenomena and it is essentially of the same character as the mechanical inertia which all bodies inherently possess. The amount of this electric inertia or the "electric mass" of a charge on a sphere is considered to be equal to the square of the charge in C. G. S. magnetic units divided by three times the radius of the sphere in centimeters. The smaller the sphere and the greater the charge, the greater becomes the electric mass. With any actual spheres the electric mass is always insignificant with respect to the real mass; or, in other words, the electric inertia of any experimentally charged sphere is enormously less than the actual mechanically observed inertia. Even if we consider the atoms of a body, and assume them to be spheres of such diameter as calculated results of observation will permit, endowed with the atomic charges determined by electrolysis, the electric mass of an atom is extremely small by comparison with its mechanical mass. If, however, we accept Prof. J. J. Thomson's theory, to which we recently called attention in these columns on page 425, we are free to assume that the atomic charge may be carried by a mere chip or corpuscle of an atom, and that an atom is composed of a large number of such corpuscles. In that case, as Prof. Fessenden shows, the mass of a corpuscle may be accounted for entirely by the electromagnetic theory; or, we may assume the diameter of the atom-chips small enough to account for inertia electromagnetically, without doing violence to any existing barriers imposed by experiment or experience.

The same intimation was conveyed in Prof. J. J. Thomson's paper in the last December number of the *Philosophical Magazine*. He showed that if the spherical diameter of the carrier of the atomic charge could be taken as about 10^{-13} centimeter, instead of about 10^{-8} centimeter; or, in other words, if a corpuscle in an atom had a diameter about 100,000 times less than the diameter commonly attributed to the atom, the inertia of matter might be accounted for electrically. This is, of course, very far from asserting that inertia is an electrical phenomenon, because the existence of atomic chips of corpuscles is not yet universally conceded, and still less can the dimensions of these supposed corpuscles be said to be known. Much more experimental evidence must be acquired before the electromagntic theory of inertia can rest upon a firm basis.

It is not essential to this hypothesis that the atomic chips should be spherical. Essentially the same effects could be produced by electric charges, whatever the form of the corpuscles. All that is

essential is an electric flux distribution within the atom of sufficient amount and intensity to give rise to the observed magnitudes of motion-resisting force, by reason of the magnetic fluxes created when the charges move. It was very hard to imagine how the necessary large amounts of electric flux could be provided for with the existing estimated sizes of atoms and their inherent electric charges. Now that it is possible to assume a subdivided atom, without transcending the limits of experimental deduction, the difficulty disappears.

If the electromagnetic theory of inertia should gain ground, we would still be faced with the outstanding problem of gravitation unaccounted for, but the explanation of inertia would be of great assistance. We should be immediately freed from the necessity of imputing inertia to the universal ether. We would start with matter inherently electrified within the atoms, and the development of motion in the atom would necessarily develop electromagnetic forces between the charge and its environing ether, these forces varying according to the Newtonian law of acceleration. It would now seem that the rhythmic vibration of ions within atoms might supply the explanation of spectroscopic phenomena, and that the charges of ions might also account for the inertia of atoms, there being a large number of ions in each atom.

It is remarkable how far electrical theories are pervading the groundwork of general physics. Optics is now a branch of electromagnetism, and theoretical mechanics, in so far as concerns the movement and inertia of mechanical particles, may perhaps become another chapter in the electromagnetic log-book. The fundamental principles of chemical affinity seem to have a similar leaning. We may hope that when all these affiliations shall have been traced and recorded, the veil which at present shrouds the nature and activities of the atom may at the same time be torn aside to show us what matter is and what electrification consists of.

THE EFFICIENCY OF A THERMOELECTRIC PLANT.

The idea of a thermoelectric plant to replace the engines and dynamos of generating stations may appear like a late and bad April joke to the practical engineer, who is accustomed to regard a thermoelectric couple as an interesting thing for experiments in lectures on the theory of electricity, but without any practical value. And his point of view is without doubt entirely right, so far as our actual, real knowledge of thermoelectricity is concerned. The paper to which we call attention here and in which this idea is put forth, is not only a summary of what has really been done, but also a discussion of what might be done—of the limits of the practical application of thermoelectricity as deduced from the fundamental principles of physical science. The paper was read by Mr. C. Liebenow before the Electrotechnical Society of Berlin, and is reprinted in a recent issue of the *Elektrotechnische Zeitschrift*.

The desire to make a radical change in the practical generation of electric currents, is not at all new-born. The conditions as they really are may be summed up by saying that so far only mechanical and chemical energy enter into the production of electric currents. But the conversion of chemical energy into electrical energy means practically oxidation of zinc, and zinc is expensive. It is much more economical to burn coal in the steam boiler and thus convert a small part of the heat of combustion into mechanical work, and subsequently transform this work into electrical energy by means of dynamos. This is a roundabout method, and as the efficiency of heat engines is necessarily limited by the second law of thermodynamics, the efficiency of the whole process is rather small. Nevertheless, it is the cheapest process we know of. It has been for some years the aim of many to devise a cell in which the chemical energy of carbon, with oxygen of the air as an agent, shall be converted into electrical energy. This is, of course, the most direct and most effective process that can be imagined; but so far no one has succeeded in devising a practical carbon cell. The latest contribution on this question was the able serial of Mr. C. J. Reed, published in this journal last year, and therein the conclusions arrived at contain little of hope. The leading German electrochemical papers, in which articles on the construction of carbon cells were quite a feature not so many years ago, appear to have dropped the subject.

And now Mr. Liebenow, an authority in several branches of electrical science, takes up the old question and presents it from an entirely different point of view. If the carbon cell is a practical impossibility (he does not say so—he does not mention it at all), perhaps thermoelectricity may help us out of the difficulty. Indeed, it is apparent at the first glance that the conversion of heat into electricity in a thermocouple is more direct than the conversion of heat into mechanical, and then into electrical, energy by an engine and dynamo. Mr. Liebenow published last summer a thermodynamical theory of thermoelectricity, and has developed equations which proved to be—in ome instances at least approximately—in surprising agreement with the facts. In his present paper he refers to this theory again. But however interesting it is, it appears to be not free from objections, and Prof. Voigt, of the University of Göttingen, has summed up his objections against theory put forth in a paper printed in Wiedemann's *Annalen*.

What appears to us as the most interesting part of Mr. Liebenow's present paper is his discussion of the maximum possible efficiency of a thermoelectric plant. The deductions are apparently independent of his special thermoelectric theory and of any particular hypothesis on the nature of thermoelectricity; they are simply consequences of the two laws of thermodynamics—that is, of the two broadest and best founded laws of physical science. His argument is somewhat as follows: Whenever heat is converted into electrical energy in a thermocouple, there is a transportation of heat from a higher temperature to a lower, and according to the second law of thermodynamics, only a certain part of the heat, dependent upon these two temperatures, is converted into electrical energy. In this respect the thermocouple is quite analogous to the steam engine. If, for instance, the two temperatures used with a short-circuited thermocouple are 1000 degs. C. and 20 degs. C., the ratio of the maximum amount of heat which can be converted into electrical energy in the system, to the whole amount of heat which is supplied to the system is, according to the law of Carnot and Clausius $(1000° - 20°) / 1273$, or about 77 per cent. By introducing an external circuit and by considering the necessary loss of Joulean heat, he calculates that in the most economical case the maximum efficiency which can be reached with a thermocouple working between the limits of 1000 degs. C and 20 degs. C. is only 28 to 29 per cent. This efficiency can be reached only under the best possible conditions, which are never to be found in practice. This result is as interesting as it is disappointing. It does not seem likely that thermoelectricity will ever play an important part in practice. Mr. Liebenow, nevertheless, remarks that even if but an efficiency of 15 per cent. can be obtained in practice, a thermoelectric plant could be used to advantage on account of its extreme simplicity and the saving of space and attendance. In the discussion of the theoretical side of the question, Mr. Liebenow establishes his points with a scientific care that renders his conclusions worthy of respect in as far as they apply. In view of past experience with thermoelectricity, it is another thing, however, to base upon them a statement such as that just quoted as to their practical bearing.

Commerce in the Philippines.

The *Moniteur Officiel du Commerce*, an official publication of the French government, in a late issue discusses the subject of "Commerce and Commercial Prospects in the Philippines." It calls the attention of those interested in the foreign commerce of France to the fact that American commerce in the Orient is making rapid developments, and especially so through the foothold which it has obtained in Manila.

The Philippine market, it says, received prior to the Spanish-American war, all sorts of articles coming from England, Spain, France, Belgium, etc. The United States, whose exports to these islands had been relatively of very insignificant importance, have since taken an important place in the victualing of Manila, which place is daily growing in importance. The business men of this city (Paris), after a few months of observation, became convinced that in order to hold their own against the American competitor, they would have to replenish part of their stock of trade with American goods, so that now one can see in all the stores of Manila, besides the foreign goods formerly imported, also a number of articles which the American manufacturers try to introduce in large quantities.

The competition on the part American products, the article continues, is bound to become more formidable the more Americans become settled in this colony, and even now old Manila business houses send orders to American manufacturers, who have acquainted them with their terms of doing business ever since August, 1898, either through detailed catalogues or more often through active and intelligent agents.

Invention of the Incandescent Lamp.

The story of the invention of the incandescent lamp by the Canadian, Woodward, has recently again been brought forward. A Canadian correspondent writes that some interesting historical data has recently been supplied by Mr. Wright, of the Toronto Electric Light Company, and Mr. Patriarche, of the Electric Maintenance Company, of Toronto, Ont., relative to the original discovery of the principle of incandescent electric lighting. This discovery is claimed to have been made in the City of Toronto, and patented in Canada and the United States prior to the time when a patent was granted to Edison; and, moreover, that the patent for the Canadian discovery was purchased by Mr. Edison at the time when he was making his original investigations and before he obtained his patent. The details of the story are that Henry Woodward, a medical student, and Matthew Evans, a hotelkeeper, of Toronto, were neighbors and frequently experimented together with a large Smee battery and induction coil, of which Woodward was the possessor. While seated at dusk one evening watching the buzzer of the induction coil, the light of the spark at the contact post attracted their attention. It impressed them with the idea that if they could confine the spark in a globe a marvelous invention would be the result. From this beginning, in the early part of 1873, Woodward and Evans worked to perfect the idea, and on August 3, 1874, they were granted a Canadian patent. The first incandescent lamp was constructed at Morrison's brass foundry in Toronto, and was a very crude affair. It consisted of a water gauge glass with a piece of carbon, filed by hand and drilled at each end, for the electrodes, and hermetically sealed at both ends, having a petcock at one end with a brass tube to exhaust the air. Woodward made the mistake of filling the tube or globe of this lamp with nitrogen after having exhausted the air. Prof. Elihu Thomson is quoted as having said that had he stopped when he had the tube exhausted he would have had the honor of being the inventor of the incandescent light as used for commercial purposes. After the invention had been tested a company was formed for the supply of electric lights to the public. Some of the original stockholders had invested capital in the enterprise before having seen the light and when asked to put up more money on the same conditions, declined. Woodward became displeased and left for Europe, and is now said to be residing in London, England. Evans died in Toronto last year. The comment on this story is that the principle of the incandescent lamp dates several decades before the Woodward experiments, and that King, Chanzy, Farmer and others in the twenty years preceding 1860 made and used incandescent lamps much superior to the very imperfect one upon which Woodward's claims are based. Moreover, the Edison claims, as sustained in the courts, were not on the discovery of the principles of the incandescent lamp but on a definite combination of parts—all well known—which resulted in the production of a practical form of the incandescent lamp.

Electric Railway in Geneva.

United States Consul Benjamin H. Ridgely, at Geneva, Switzerland, reports to the State Department that within six months an electric street railway, projected by Mr. Henry E. Butters, of San Francisco, Cal., and constructed by Mr. Stephen D. Field, a well-known electrical engineer of New York, will be in operation in that city. Mr. Butters and his associates have secured a controlling interest in the Narrow Gauge Street Railway Company of Geneva, which owns and operates some 72 kilometers (44.74 miles) in the city and suburbs. The projectors also secured an option on the franchise and property of the Compagnie Générale des Tramways Suisses, which owns and operates 26 kilometers (16.56 miles) in the heart of the city and its environs. The price to be paid if the right under this option is exercised, as it doubtless will be, is 6,500,000 francs ($1,254,500). The projectors have also secured a federal charter under the title of "Compagnie Genevoise des Tramways Electriques" and obtained concessions to lay their tracks on some of the finest streets and quays of the city.

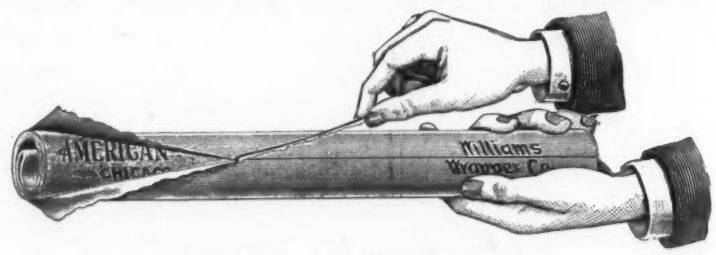
The new company was organized with a capital of 5,000,000 francs ($965,000); but none of the stock has yet been issued or sold, although it has probably been largely apportioned. It is understood that the money for the construction is being furnished by the Paris Bank of South Africa. London capitalists are also interested in the venture, and it is likely that the new company in a short time will own and control all the street car lines in the city and Canton of Geneva. The American overhead trolley system is being used and the American system of conduits for underground cables, for the first time in Europe.

The charter of the new company requires that the materials used in construction be bought either from Swiss manufacturers or from Swiss houses representing foreign manufacturers. This for the moment virtually bars United States manufacturers, as no American concern has a Swiss agency. The cars, however, are being built on the American plan, and one car has, by special permission, been shipped from the factory of a well known car manufacturing company in Philadelphia. France is largely furnishing the wire. The only American material that has yet been used is the Brown-Edison plastic rail bond.

Although Geneva has a large water-power force for generating electricity, it is not believed that this plant will be able to furnish sufficient electric power for the new street railway. Mr. Field also thinks that the price asked by the city, 12½ centimes (2⅜ cents) per kilowatt hour—is unreasonably high. Electricity can probably be produced by steam in Geneva for from 6 to 8 centimes (1⅛ to 1 5-9 cents) per kilowatt hour, and Mr. Field is willing to pay 8 centimes. The question is yet to be adjusted.

Mailing Notice.

Owing to frequent complaints of the receipt of empty mailing envelopes, from which the copy of the paper evidently had fallen out in transit, we have decided to mail the ELECTRICAL WORLD AND ENGINEER (beginning with the issue of April 28) in a wrapper which is provided with a string, so that to open the wrapper it is merely necessary to pull the string as shown in this cut. We would be pleased to receive comments from our readers upon the condition in which the paper reaches them when the wrapper is used.



METHOD OF OPENING THE WRAPPER.

The Polyphase Distributing System of the Metropolitan Street Railway Company of New York City—III.

BY J. E. WOODBRIDGE.

THE OIL CIRCUIT BREAKERS.

A CHARACTERISTIC feature of the high-tension circuits throughout the generating station and the substations of the Metropolitan company is the liberal use of an improved type of electro-pneumatic oil-break switches, which in this installation take the place of switches, circuit breakers and fuses in low-tension work. Indeed, the only devices through which the high-tension currents pass on their way from the generator windings at the power plant to the transformer windings in the substations are oil switches and series transformers, not a single air-brake switch being allowed in the high-tension circuits.

Following a recent change of terminology adopted by the General Electric Company by which the word switch is applied only to a device intended to be opened only when no current is passing through it and the word circuit-breaker is intended to signify any instrument—either automatically or manually operated—intended to open under load, the oil-break devices here described will be called oil circuit breakers.

The main power station will contain over 100 of these oil circuit breakers, all of the same size and same general style, differing only in current-carrying capacity, and the same type of circuit breaker will be used in even greater numbers for all high-tension work in the substations. Not one of this great number will be of the type now becoming popular for 2000-volt work, operated by hand and mounted on the back of the switchboard, but each one will stand alone on its own foundation, with its three phases in three separate cells separated by brick walls, and all will be operated by pneumatic power. On this account a detailed description of this improved device may be of interest.

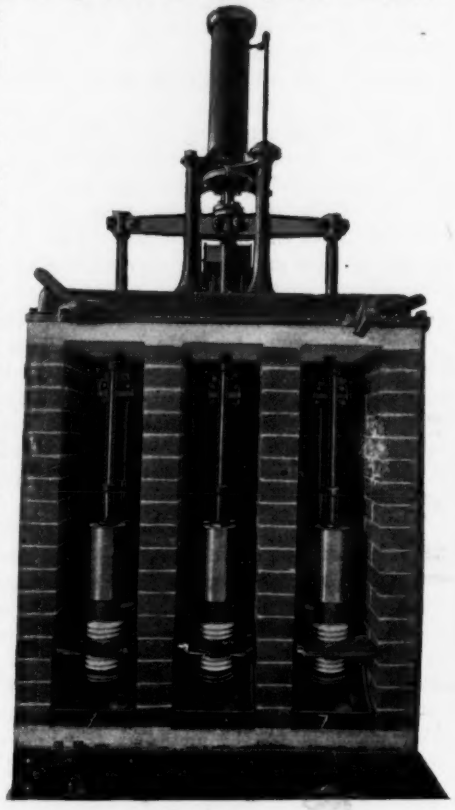


FIG. 10.—VIEW OF ONE OF THE NEW "FORM H" 300-AMPERE, 10,000-VOLT, THREE-PHASE OIL CIRCUIT BREAKERS.

The new design known as "Form H" embodies several improvements over those which the readers of these columns may remember as having been used for the same purpose in the central station service of the Brooklyn Edison and Chicago Edison companies. In order to show the "state of the art" of oil circuit breaker design, views and circuit diagrams of the older type are given for comparison. A view of one of the new pattern is shown in Fig. 10. Like its predecessors the movement of the parts is accomplished by the aid of compressed air, which forces a piston up or down in a vertical cylinder above the top of a brick structure enclosing the live parts. The valve controlling this cylinder is operated by the one magnet with which the device is fitted, the circuit of this magnet running from the operating switchboard. When this magnet is excited and draws its armature down it pulls the valve—which is a miniature of the plain unbalanced D valve of simple engines—into such a position as to admit air above the piston and exhaust it below, thus forcing the piston down and closing the main-current contacts. If current is cut off from the magnet by any means the valve is instantly restored by a spring into such a position as to admit air below the piston and open the contacts. The magnet is wound with two coils, one of fine and one of coarse wire, connected in series with each other. The movement of the armature works an automatic switch which short circuits the high resistance part of the winding when the armature is up, thus allowing a powerful current to pass from the constant-potential source of supply to draw the armature down with plenty of reserve force. As soon as the armature is drawn down, the increased resistance thrown in by the automatic switch reduces the flow of current through the magnet winding to an amount only sufficient to hold the armature in the down position, thus economizing current, which must be left on as long as the oil circuit breaker is closed. These magnets are supplied with current at 110 volts obtained from the exciters in the main generating station, and for small direct-coupled 550 to 110-volt motor generators in duplicate in each sub-station. The high-tension ends of these motor generators take the current from the storage batteries of the sub-stations inside the storage-battery breakers, so that current for this purpose will not fail even if the breakers of the sub-station rotaries and of the batteries open in case of a severe overload. The compressed air for the pneumatic cylinders of the oil breakers is supplied by motor-driven air pumps with automatic controllers.

Those who are familiar with the older type of oil breakers mentioned above will recollect that each of them has three magnets, one operating to admit air above the cylinder, the other to admit air below the cylinder, and the third acting as a mechanical latch to hold either one of the other two valves in the open position except when the third magnet is energized. The controlling circuits of one of these older types are given in Fig. 12, showing how the controlling switch releases the latch before moving either of the magnets attached to the valves. With the new type of breaker the controlling switch simply opens or closes the circuit of the one magnet operating the one D valve. On this account the oil breakers of the older type would make no move if current failed them, whereas those used by the Metropolitan company will all open if the source of current supply for the magnets fail. In the case of a substation, the failure of the 550 to 110-volt motor generators would with the new type shut down the station unless an attendant could anticipate it and open a free exhaust on the compressed air system, in which case there would be no compressed air to lift the pistons of the oil breakers. With the older arrangement of magnets, on the other hand, the failure of the 110-volt supply would make it impossible to operate the oil circuit breakers either way, and any fault of the opening magnet or of the latching magnet—the closing magnet remaining operative—would allow the oil circuit breaker to close, after which it could not be opened. In the new type any fault of the magnet or its controlling circuits causes the breaker to open.

FIG. 11.—VIEW OF ONE OF THE OLDER TYPES OF OIL CIRCUIT BREAKERS.

The main piston of the oil circuit breaker raises or lowers a metal crosshead carrying three wooden rods which extend down into three cells, each containing the switching apparatus of one leg of the circuit. The arrangement of these parts is shown in the drawings, Fig. 4. The cells are separated from each other by four-inch brick partitions to act as barriers and prevent a burn-out in one cell from spreading to the others. As the opening of two legs breaks a three-phase line an arc in one cell will not incapacitate the breaker. The circuit breaking parts proper consist of two

brass cylinders or cans for each phase, into the tops of which two copper rods extend from above, these two rods connecting the two cylinders together when lowered by the crosshead to which they are attached. In this respect the new form of circuit breaker differs radically from the older form in which both breaks of one leg are made in one tub of oil, as may be seen by the view given of one of the old machines. The great amount of oil that would be contained in the 100 or more switches of the Metropolitan station if of the older form made a change in this respect advisable on account of the fire risk. The new form would appear to give little room for pulling a long arc, but it has proven sufficient.

The two brass cylinders in each cell are respectively mounted on two copper castings, to one of which is connected the incoming lead and to the other the outgoing lead of the same phase. Each cylinder is nearly filled with transil oil of a suitable grade and is covered by a metal cap which carries a long insulating sleeve in stuffing box and oil wiper around the rod. When the three pairs of rods on one crosshead are lowered their ends make contact with the copper castings under the oil and the circuit is closed. When the rods are lifted the circuit is broken under the oil at two points in each leg, or six points in each complete three-phase switch.

The range of movement of the crosshead is a foot, giving in each leg an opening of nearly two feet, and thus in series with each phase—considered as delta connected—an opening of nearly four feet. The enclosure of the cans containing the oil gives a certain amount of compression to suppress arcing if the drowning of the arc by the oil is alone not sufficient. Although the long insulating stuffing box does not fit tightly around the rod any arc which might form on breaking the circuit causes such a sudden expansion of the oil that the air above it in the can does not find time to escape, thus preventing the arc from blowing the oil away from its path. The brass cans are lined internally with fibre to prevent the arc from jumping from the rod to the metal of the can if it is drawn up through the oil to its surface.

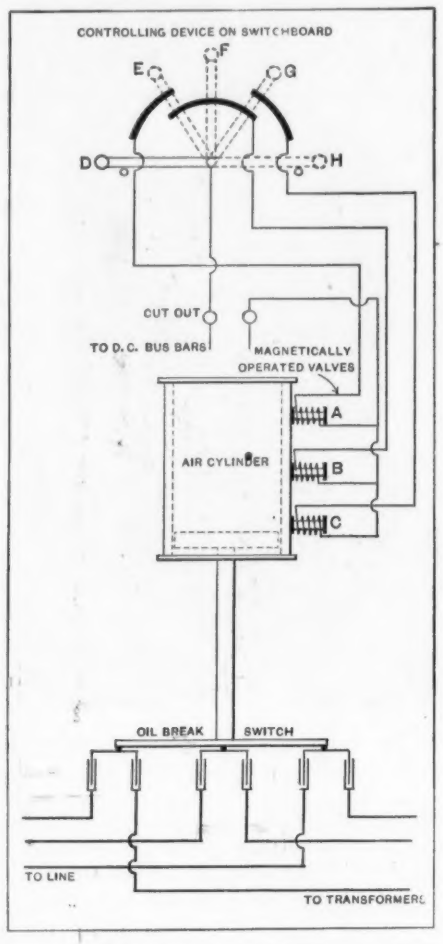


FIG. 12.—CONTROLLING CIRCUITS OF THE OLDER OIL CIRCUIT BREAKERS.

The exact construction of the contacts between the rods and cylinders is of interest owing to the fact that the apparatus is rated at 300 amperes per phase, all of which must be carried through the surface of a ¾-inch rod under oil. On the lower end of each copper rod is screwed a removable blunt-pointed brass tip. When the rod is lowered, it passes through two tubes or sleeves, each split into four segments which surround the rod tightly and are forced against it by springs, the whole arrangement resembling a metallic packing ring for a valve or piston rod. Of the two split sleeves, the lower one which the rod enters last and leaves first is made of copper and the upper one of brass. When the rod is drawn up the final opening is between the brass sleeve and the brass tip, thus making use of the non-arcing metal principle. When the brass tip leaves the brass the segments of the latter close in and rub against the tapering end of the rod, transferring the final break and any pitting that may occur to the tapered end of the rod where it will not scratch and injure the surface of the copper sleeve the next time the rod goes down.

The piston and crosshead of the circuit breaker are prevented from falling and thus closing the circuit, if the air fails, by a hook or latch which catches the crosshead in its raised position. When air is turned on above the piston it is led by a branch pipe to a small auxiliary cylinder, this auxiliary cylinder releasing the latch and allowing the crosshead to fall as well as to be forced down by the air pressure, thus promptly closing the circuit. Each lead into and out from the oil cylinders comes up through the floor and terminates in an inverted crown of copper leaves, termed in the drawing Fig. 13, a leaf contact. Normally there rests upon each of these leaf contacts a disc contact fixed to the copper casting which forms the bottom of one of the oil-filled cylinders or cans. The two copper castings in each cell are fastened to corrugated porcelain insulators mounted on a small table. By means of a cam and a lever, forming a lifting device, this table can be raised or lowered. When raised the disc contact is lifted away from the leaf contact, giving an air opening in the circuit each side of the breaker in each phase. This is provided to allow for repairs or adjustment of the live parts of the breaker. The circuit is never, of course, broken at this point with current on.

These oil circuit breakers are made in two capacities, the larger rated at 800 amperes and used for the generators and for groups of feeders, the smaller with a capacity of 300 amperes for the feeders and for all of the high-tension work in the sub-stations. The breakers of the two ratings are of the same size, the difference between them being that that with the larger capacity has an auxiliary or primary contact in air made by means of a brush of copper leaves bridging from the top of one of the brass cans to the top of the other of the same phase, and thus shunting the contacts under the oil. Normally this primary contact in air carries the greater part of the current, but when the breaker is opened the primary contact is broken first, throwing the whole load on the rods and their surrounding sleeves under the oil.

These oil circuit breakers have opened under all conditions of load on the generators, the feeders and the rotaries. They have opened in the generator leads with a dead short circuit on the line, giving 800 amperes per leg at no voltage rising to 6600 volts as soon as broken. They have also opened a highly inductive load of at least 600 amperes at full potential, working perfectly in every instance.

The local 125-volt direct-current circuits of the magnets of these oil circuit breakers are closed through controlling switches which may be operated by hand, but are in many cases fitted with magnetically operated triggers designed to make them and the oil circuit breakers open automatically. These triggers are controlled by magnets and release the switch blades when their magnets are de-energizing, making the controlling switches into automatic circuit breakers serving as relays to transmit a circuit change from their magnets to the magnets of the valves of the oil circuit breakers. There are two types of these automatic controlling switches, one designed to operate the oil circuit breaker in case of an overload upon the line, and the other designed to operate for either overload or reversal of the direction of power transmission. In the former type, the connections of which are shown in Fig. 14, the coils of the automatic controlling switch are connected with series or current transformers in two legs of the line to be protected, so that in case an overload comes upon this line the magnets in the automatic controlling switch are energized, pulling up their armatures, giving a hammer blow to the trigger, releasing the blade of the automatic controlling switch, and opening the circuit. The other type of automatic controlling switch has a direct-current magnet, no alternating currents being admitted to the switch at all. The circuits of this direct-current magnet are opened or closed in relays actuated by the alternating currents. The trigger is released in this controlling switch when the magnet is de-energized. In order to prevent arcing or burning of the contacts of the relays that first close and open the circuit of the magnet of the controlling switch (these contacts being somewhat delicate) this magnet is wound differentially with two coils, one of which is normally closed to hold the armature up, the other—wound in the reverse direction—being thrown in parallel with it to demagnetize and release the plunger and allow the switch to escape from the trigger.

The circuits of this device are shown in Figs. 15 and 16, one showing the connections to an overload relay and the other to a reverse-current relay. It will be seen that the differential tripping coil of the controlling switch is connected in series with the circuit from the controlling switch to the magnet of the oil circuit

breaker. A contact is so arranged that while the switch is being closed the differential tripping coil is short circuited by the switch blade so that the full difference of potential at the source of supply is on the coarse coil of the magnet on the oil circuit breaker, setting up a large current in this coil and giving quick action to the valve. As soon as the blade of the controlling switch reaches the closed position the short circuit around the differential magnet is removed, and as soon as the valve is operated a fine coil is connected in series with the coarse coil in the magnet of the circuit breaker valve. The overload relay consists simply of two alternating-current solenoids connected respectively in the secondary circuits of two series transformers in two legs of the line to be protected against overload. In case an overload current passes through either of these transformers the solenoid of the corresponding relay draws up its plunger, closing a contact which throws in the differential winding of the magnet of the controlling switch, which in turn releases the trigger of the controlling switch, the latter opening and cutting current off from the magnet operating the valve of the oil circuit breaker, which in turn is forced up by compressed air, breaking the main 6000-volt circuit.

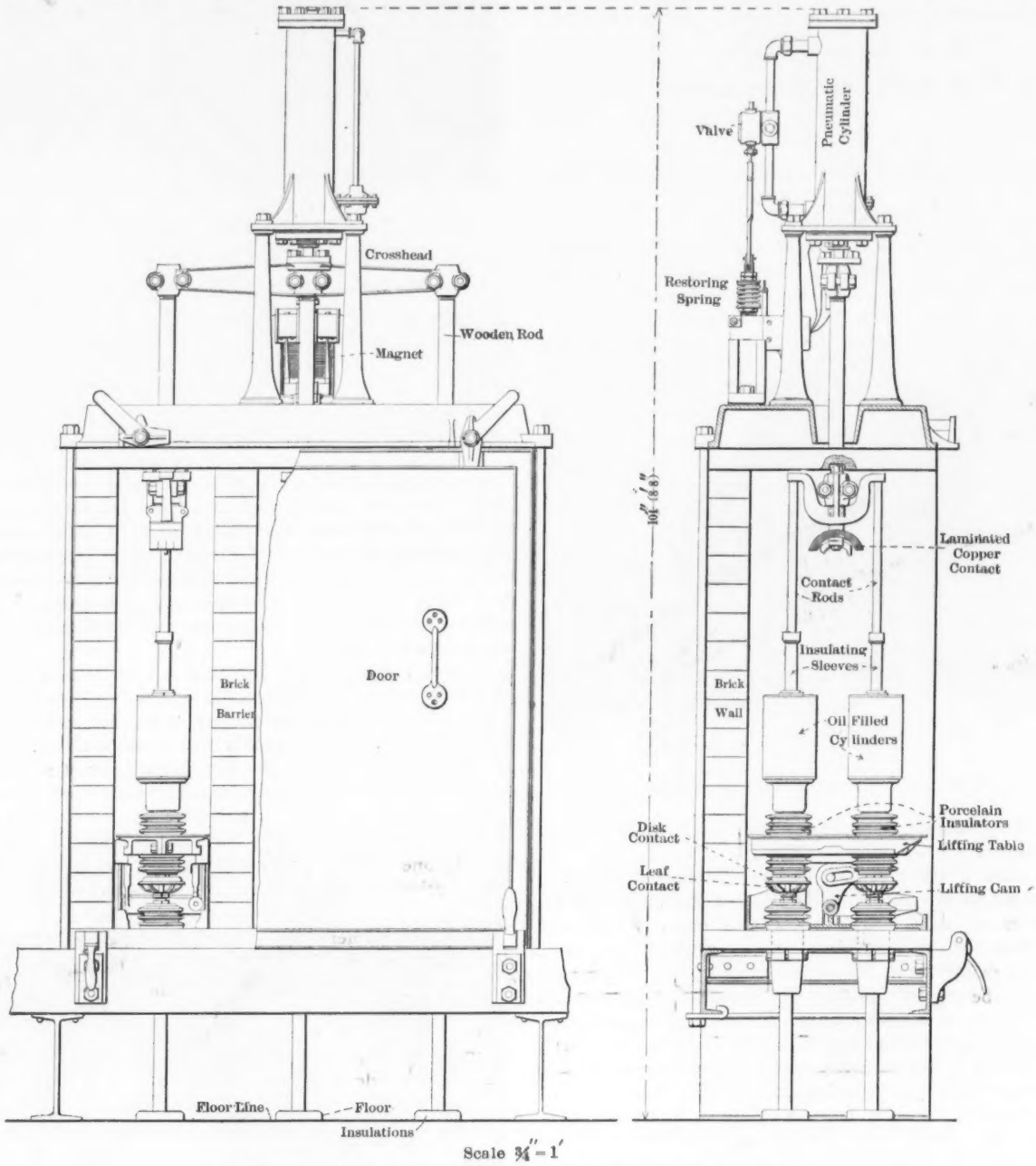


FIG. 13.—ELEVATION OF ONE OF THE OIL CIRCUIT-BREAKERS.

The reverse-current relay, as its name implies, is intended to operate in case the power in the feeder or other circuit tends to flow in a direction the reverse of normal. Its location and purpose will be described later in relation to the circuits. With alternating currents it is, of course, impossible to determine the direction of flow of power from the direction of flow of the current alone, as is possible with direct current, since the current is constantly reversing, no matter which way the power is flowing. The only way to determine whether the transmission of power is in one direction or the other in an alternating circuit is to obtain some reaction between the current and the electromotive force. This is obtained, as shown in the diagram, Fig. 16, by using a small motor as a relay. The motor resembles closely an ordinary direct-current General Electric fan motor with laminated fields. Current from a series transformer is circulated in the field winding of this motor-type relay, and current from a potential transformer is passed through the armature and commutator via the ordinary brushes, the armature circuit being preferably supplied from Y-connected transformers (although not so shown in this drawing) so that the currents in both the armature and the field of this motor relay are in phase with each other when the load is non-inductive. Obviously the reaction of the armature and field gives a torque to the relay in one direction. If the flow of power reverses in the main circuit to which the series and potential transformers of the reverse-current relay are connected, the direction of the mechanical torque exerted in the relay reverses. The armature is not allowed to rotate, but carries a crank which rests normally against a dead back stop, but which turns into contact with a live front stop when the mechanical reaction reverses. This live front stop is connected, as shown in the diagram, to the differential magnet of the controlling switch, operating the latter and thereby opening the oil circuit breaker automatically. Two relays are necessary in each line connected in two different phases so as to protect against a reversal in any one of the three phases.

There is incorporated in the structure of those controlling switches, which have automatic releasing triggers, an ingenious detail to indicate whether the switch has been released by the automatic devices or pulled open by hand. The handle has two positions with reference to the switch blade, in either of which positions it is held by a notch when once set there. On pulling the switch open by hand, the inclined edge of the trigger resists the motion of the blade, compelling the handle to slip to the lower notch before it will pull the blade away from the trigger. On closing the switch the handle slips to the upper notch before it will push the blade in. If a switch is open with the handle in the upper notch it indicates that the switch has been released by the magnet and trigger, and has not been pulled open by hand. On looking down the line of switches any one that has opened automatically will be seen instantly as its handle will stick out at a different angle from the others.

Some Work with Polyphase Apparatus.

BY J. L. THOMAS.

THE plant now operated by the Consolidated Lighting Company, of Montpelier, Vt., is composed of a water-power generating station at Bolton Falls, on the Winooski River, about seventeen miles from Montpelier; a transformer station at Waterbury, four miles from Bolton; a steam plant and two step-down transformer houses in the city; and a step-down transformer

FIG. 1.—EXTERIOR OF A TRANSFORMER HOUSE.

house that is being erected at Barre, six miles from Montpelier and twenty-three miles from Bolton Falls.

The Bolton plant consists of two General Electric three-phase, 60-cycle, rotating-field generators, which deliver the current direct to the lines at 11,000 volts. They are 450-kw capacity each and direct-connected to horizontal turbines, operating under 50-ft. head.

This plant is probably about like others of this class, which have been so often described, with perhaps the possible exception that the generators can be connected in multiple; and when so united, the service is much improved, as the voltage fluctuations are nearly overcome. This may be due to the increased momentum of the two machines, which give a balance-wheel effect to sudden changes in load.

The seventeen miles of wire between Bolton and Montpelier, consist of three No. 4 bare copper wires supported on porcelain insulators, and run side by side on one end of a 6-pin cross-arm. Three more wires are to be added, which will be used for power purposes.

Figs. No. 1 and 2 show the exterior and interior of one of the transformer houses. The equipment consists of three 100-kw transformers, 11,000 to 2000 volts, of the air-blast type, and are provided with expulsion cutouts and oil switches on the 11,000-volt side. These are located in the loft near the entrance of the wires, and provide for cutting the current entirely out of the building, if necessary.

The 11,000-volt wires are connected to the top of the transformers, and the 2000-volt wires, being connected at the bottom, pass under the floor to the switchboard, where they are divided into three single phase circuits, which lead to different sections of the city.

These distributing circuits are provided with double-pole, double-throw switches, ammeters, circuit-breakers and lightning arresters, and, by means of the switches, can be furnished with current from the steam plant at Montpelier or the water-power plant at Bolton.

FIG. 2.—INTERIOR OF TRANSFORMER HOUSE.

The power line is in process of construction, and is to furnish the connecting link between the two plants.

The transformer houses are 18 x 24 ft. and give room for the necessary apparatus, and also leave ample space for constant-current transformers and equipment for alternating current street lighting, which are to be added. They are covered with iron, and the air from the transformers has kept the temperature as high as 60 when the thermometer showed 20 below zero outside.

The steam plant is located on the same river, one mile from the business portion of the city, and consists of two high-speed engines, with the usual steam apparatus; five water wheels, 10-ft. head; four T. H. arc dynamos; one 150-kw Westinghouse, three-phase, 2000-volt, 60-cycle generator; several small alternating current machines; and a 75-kw, 500-volt, direct-current generator; all of which are belted to a jack shaft and are provided with clutches and transmitters, so that any engine, water wheel or dynamo can be cut in or out, as needed.

Before the new plant was started, this station furnished current for both street and commercial lighting in Montpelier, Barre and Berlin, and for operating an electric road in and between the cities. It is now used as a relay, and for operating the T. H. arc machines for street lighting. As the water power is not sufficient to do this work, step-down transformers have been installed—the same as shown in Fig. 2—and the 2000-volt current is brought to the switchboard of the 150-kw Westinghouse machine in place of the line wires which are used when this is operated as a generator; a small transformer and phase lamps are connected in.

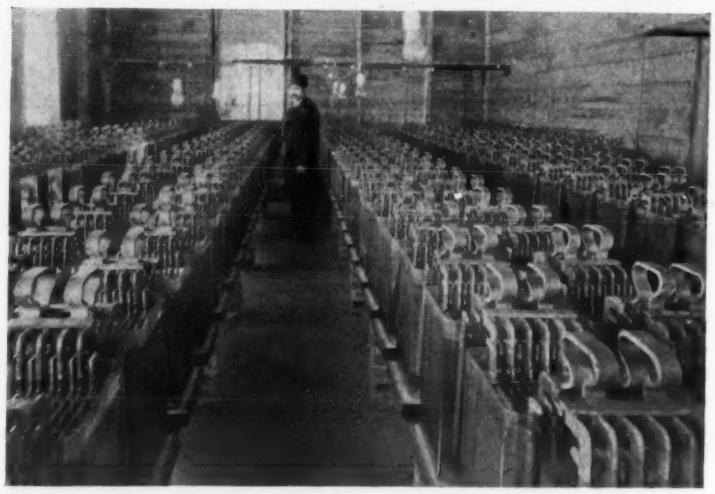


FIG. 3.—STORAGE BATTERY ROOM.

This adapts the machine to be used as a generator or a synchronous motor. To operate it as a motor, the water wheels or one of the engines, are started up, and it is made to build up its current

just the same as if it were a generator; as it is carefully brought up to speed, the phase lamps begin to work, and the switch is thrown at the period of their greatest brilliancy or when they are entirely out, and then the load can be added and the motor will take care of it. The service wires are all provided with double-throw switches, so that power and lights can be furnished from either plant.

The three 100-kw transformers, 11,000 to 2000 volts, at this place also furnish current for a Westinghouse rotary converter which, in connection with a storage battery, operates the electric road. The

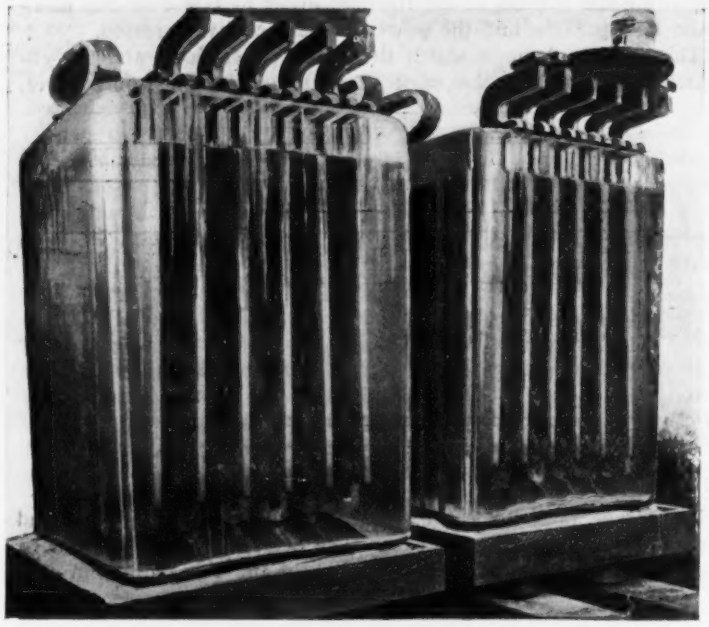


FIG. 4.—TWO OF THE STORAGE CELLS.

road is about ten miles long, and runs four to seven cars, according to the travel. The rotary converter is of 160-kw capacity, and the storage battery has 248 cells, each composed of eleven plates, 10 ins. x 10 ins. square. Fig. 3 shows the Battery Room, and Fig. 4 shows the deposit in the bottom of the glass jars, which have been in constant use since July 1, 1898. These are a fair average of the battery, which has never been touched except to add a little clear water to supply that lost by evaporation. The sediment in the jars reaches about half way to the bottom of the plates. The glass jars rest on a bed of sand contained in a square box supported by glass insulators. So far, there has never been the least trouble with any part of the battery, which has capacity to operate the road about

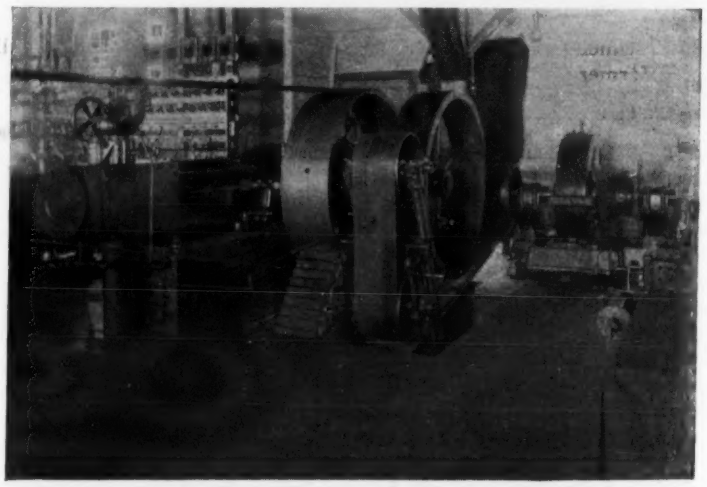


FIG. 5.—A BELT DRIVE.

an hour after the generator is shut down, and ordinary repairs can be made without stopping the cars. The average current required for this rotary converter is 96-kw, as measured two-phase between the rotary and the Westinghouse transformers, where the 2000-volt, three-phase current is transformed to 400 volts, two-phase. On heavy pulls the battery does about one-third of the work.

Switches are provided so that the battery and feed wires can be changed from the rotary converter to the direct-current generator at the steam plant, which is shown in Fig. 5. This belt drive is of interest because it solves a problem constantly coming up with station men, viz.: "Where can I make room for another machine?" As will be seen, this takes up hardly any more room than direct-connected machinery, and has the advantage that the generator can be stopped and started as desired.

The road was operated from this 75-kw generator for several months, and the power was very satisfactory, the output of the machine ranging from 75 to 175 amperes. The storage battery was much more active than when used with the rotary converter, and at almost any time it could be seen taking a charging current of 125 amperes, and perhaps the next minute giving out 300 amperes. The average output of the direct-current machine was 62-kw as compared with 96-kw required for the rotary converter.

The operation of the three-phase apparatus mentioned has been very satisfactory. Its extreme flexibility adapts it for many desirable combinations, while the applications mentioned have demonstrated that well designed three-phase electrical machines can be successfully operated together when built by different manufacturers.

Power Transmission Schemes at Duluth, Minnesota.

By Frank W. Springer.

THE water-shed of western Lake Superior, as shown by the map, Fig. 1, is not a greater area than that included within a circle of fifty miles radius, drawn with Duluth as a centre. At the circumference of the circle this water-shed is from 600 to 1200 feet above the lake level. The bluffs on the north shore at Duluth vary in height from 500 to 800 feet, while the south shore is mostly lowland. The two rivers to be considered in this article, the Black River on the south and the St. Louis River on the west and north, have cut these bluffs back for a distance of about fifteen miles, measured in a straight line from Duluth. At these points are found rapids and falls of considerable height, while above and below both rivers are comparatively smooth. Of the St. Louis as a water power, the following may be said:

It drains an area of 38,000 square miles composed of pine land, swamps, lakes and some arable land. The rainfall may be given as thirty inches per annum. There are two periods of low water. One is due to the summer drouth and the second is caused by the freezing of the small streams and swamps, many of which freeze solid. The minimum flow occurs in winter, when the power may

FIG. 1.—WATER SHED OF WESTERN LAKE SUPERIOR.

be estimated at 15,000-hp at a head of 600 feet. The problem has been to augment this minimum flow. It is safe to say that very close to a million dollars have been spent in preliminary surveys, options, etc. In fact, the water power of the St. Louis River has come to be such a joke on account of the innumerable unrealized projects to utilize it, that it is difficult for anyone outside of Duluth to take it seriously. Of the many schemes proposed by some of the

best engineers of the country, the following are taken as most striking:

1. A dam from 80 to 100 feet high to be built above the town of Cloquet. This would give a reservoir 60 miles long by one mile in width, submerge a railroad which has been built in the river valley, also a part of an Indian reservation, and, worst of all, be a constant menace to the town.

2. Dam the outlets of the larger lakes which constitute the principle sources of the river. These dams would need to be but a few feet in height.

3. The adjoining water-shed on the north is about 60 per cent. as large as that of the St. Louis. At one point the headwaters have the same source. A dam 20 feet high and a channel 12 miles through a swamp would divert the adjoining waters into those of the St. Louis. Also a reservoir of 30 square miles and 10 feet deep

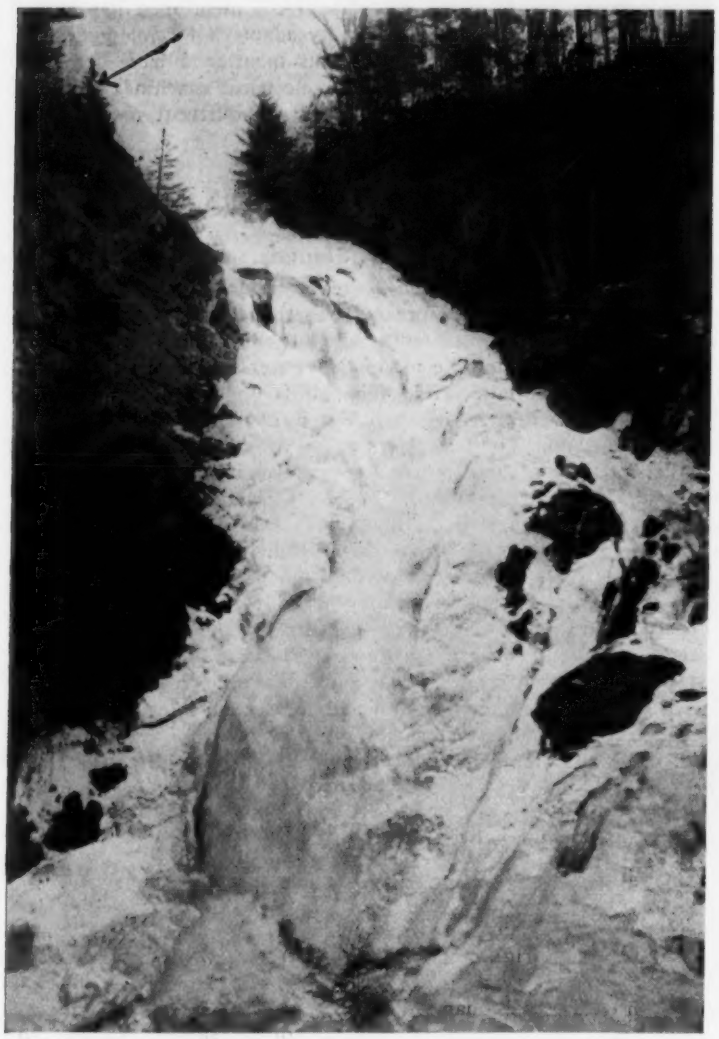


FIG. 2.—LOWER FALLS OF BLACK RIVER.

could be established. From an engineering standpoint, this latter seems to be the most complete solution of the problem.

The falls and rapids of the river, embracing a head of about 400 feet, extend along the river for a distance of three miles, the nearest point of which is about 12 miles from Duluth. The riparian rights to this property are held by Mr. J. Cooke. With the understanding that Mr. Cooke would sell his interest for about $1,000,000, the Minnesota Canal Company was formed, and it was planned to build an open canal from Cloquet to Duluth, a distance of 25 miles. Its object was twofold. In the first place, an income of $100,000 a year was expected for the use of the canal in floating logs to Duluth. On account of the falls it is now necessary to bring them by rail. In the second place, it was intended to construct a reservoir on the bluff above Duluth and from this point distribute water under a head of 600 feet to various power users. This company expected to develop over 100,000-hp. The high figure at which Mr. Cooke held his rights alone prevented this plan from being carried out. This company is said to have expended $300,000. These dreams were indulged in and paid for before long-distance transmission by electricity had become practicable.

Lately, another St. Louis power development company has been formed. It has acquired the rights necessary, and seems to have every prospect of utilizing a part at least of the St. Louis water power. A canal is to be built from a point above the rapids for a distance of three or four miles down the river. From this, 800 feet of pipe line will be run to the power house, placed in the bed of the stream. This will give a head of over 350 feet, or something like 10,000-hp net at minimum flow. The power thus obtained will be transmitted to Duluth by the use of polyphase generators, step-up transformers, etc. As the demand for power increases, dams will be built at the outlets of the various lakes and small streams which constitute the sources of the river, in order to tide over the minimum flow periods, and the power house capacity increased.

The country through which the Black River flows and the climatic conditions are the same as those of the St. Louis River.

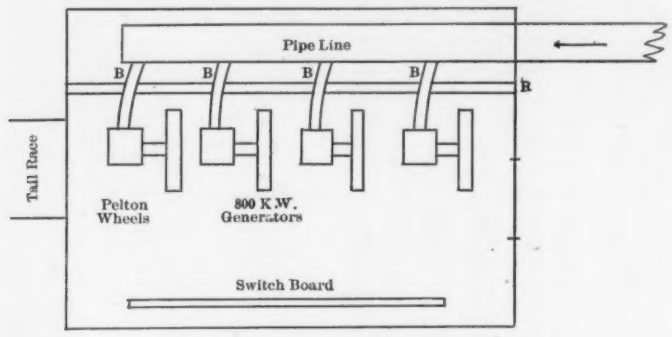


FIG. 3.—PLAN OF POWER HOUSE.

The average rainfall for the past eight years is 26.64 inches, and for the last 30 years 33.01 inches. The decrease is probably due to cutting off the timber. A large part of the rain falling in this

FIG. 4.—LOG DAM ON BLACK RIVER.

region is brought by northeast winds from Lake Superior. The reason that this power has not been considered before is that it was wholly unavailable until the application of long-distance transmission by electricity became practical. A company known as the Black River Falls Company has been formed, 1000 acres of land purchased, which gives complete control of the water power, and plans outlined to transmit the power to Duluth and Superior. In fact, it is simply a question of marketing the power which delays actual construction.

Owing to favorable conditions, it is estimated that it will not cost more than $55 per horse power to distribute this power in Duluth and Superior. As will be seen below, the storage necessary to take care of the minimum flow can be obtained at a comparatively low cost. At present the minimum flow is said to be 3500 cu. ft. per minute. The upper falls have a height of 35 feet. A masonry dam 20 feet high will be built across the gorge at the head of these falls, making a total head of 55 feet, and giving a flowage of 6,000,000 cu. ft. The cost of this structure will not exceed $5500.

The lower falls (Fig. 2) are located 4000 ft. below, and are much higher than the upper falls. The power house, 50 feet by 70 feet

long, will be placed in the bed of the stream at a point 7200 feet below the upper falls, a steel pipe line 54 inches in diameter being run from the dam across country to the Pelton water wheels in the power house. The pipe line is to be buried to prevent freezing. As the total head is 330 feet, the lower half of the pipe will be made of ½-inch steel plate.

The source of Black River is a lake of the same name, with an area of about 300 acres. A dam 10 feet high and 100 feet long, built one-half mile below the lake, will raise the lake four feet, increase its size to 900 acres, and give a total flowage of 210,000,000 cu. ft. The dam can be constructed of logs at a cost of $4000.

A second dam of similar construction, 500 feet long, costing $5000, and located in a gorge 10 miles below the lake, would give a storage of 50,000,000 cu. ft., and a third dam, 35 feet high, 300 feet long on top, costing $6000, built at a point 10 miles below the second, would increase the flowage another 50,000,000 cu. ft.

Two direct-connected polyphase 800-kw generators are to be installed, together with five (one reserve) oil transformers, raising the pressure from 440 to 18,000 volts. A similar set of transformers will be used at the receiving end. The pole line will consist of 35-foot cedar poles, eight inches at the top, and set 52 to the mile, with 3-pin cross-arms and 24-inch spacing, and No. 1 bare copper wire, mounted on three-part Locke insulators.

Fig. 3 shows the general plan of the power house. A release valve is placed at *B* on each one of the intake pipes. *R* is a heavy wall separating the dynamo room from the pipe line, protecting the machines in case of a break in the pipes. Fig. 4 is a view of a log dam used by lumbermen in floating their timber down the Black River. It shows very well the general character of the country of northern Minnesota and Wisconsin.

With the prospect of the immediate development of two such powers as those of the Black and St. Louis Rivers, it looks as though what had long been hoped for by the people at the head of the lakes would soon come to pass—that is, the beginning of the manufacture of iron and steel at Duluth and Superior.

The Elements of Illumination—I.

By Dr. Louis Bell.

WHILE even the Esquimaux and the Patagonian use artificial light and civilized peoples count it a necessity, it is seldom used skilfully and with proper knowledge of the principles that should govern its employment. Since the introduction of electric lights the very facility which gives them value has caused more zeal than discretion in their use. It is the purpose of the present articles to set forth some of the fundamental principles, optical, physiological, and æsthetic, which underlie the proper use of artificial illuminants, and to point out how they may be advantageously adapted to existing conditions.

To begin with, there are two general purposes which typify two quite distinct branches of the art of illumination. First comes the broad question of supplying artificial light for carrying on such avocations or amusements as are extended into the hours of darkness. Following this is the case of scenic illumination directed at special objects and designed to produce particular effects or illusions. Lighting a shop or a house exemplifies the one, lighting a picture gallery or the stage of a theatre the other. Each has a distinct purpose and requires special means for its accomplishment. Confusing the purposes or mixing the methods often leads to serious mistakes. Sometimes both general and scenic illumination have to be used coincidently, but the distinction between them must be fully realized even when it cannot fully be preserved.

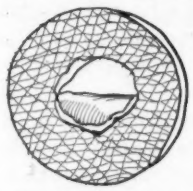


FIG. 1.—LEATHER GOGGLES.

General illumination, whether intended to serve the ends of work or play, must fulfill these conditions; it must be fully adequate in amount, suitable in kind, and must be so applied as not to react injuriously upon the eye.

It must be remembered that the human eye is not merely a rather indifferent optical instrument, but an organ which has through unfathomable ages accumulated the characters wrought upon it by evolution until it bears the impress and incurs the limitations of its environment. It works best over a rather limited retinal area and through a range in intensity of light, which, while great, is immensely smaller than the range available to nocturnal creatures. It has, moreover, become used to, and adapted to, light coming obliquely from above and resents strong illumination from any other direction, whether natural or artificial. It seems to be well established, for example, that the distress caused by the reflected glare from sand, or water, or snow, and the grave results which follow prolonged exposure to it are due not so much to the intensity of the light as to the fact that it is directed upward into the eye and is quite insufficiently stopped off by the rather transparent lower eyelid. Ordinary dark glasses are small protection in this case, but if the lower part of the eye be thoroughly guarded no difficulty is found. The Alaskan Indians evolved a very effective protection from snow blindness in the shape of leather goggles with the eye arranged as shown in Fig. 1. The eyepiece is merely a round bit of leather with a semi-circular cut made for the peep hole, the resulting flap being turned outward and downward, so that the eye is fully guarded from brilliant upward beams. Blackening the whole lower eyelid with burnt cork is stated by one distinguished oculist to be completely efficacious for the same reason.

It is more than likely that the bad effects ascribed to the habit of reading while lying down are due largely to the unwonted direction of the illumination, as well as to the unusual direction of the eye's axis.

All these matters are of fundamental importance in planning any illumination to facilitate hard visual work. Their significance is that we are not at liberty to depart widely from the distribution and character of daylight illumination. Of course, one realizes at once that the eye is neither fitted nor habituated to working to advantage in anything like the full strength of sunlight, but its more general properties—steadiness, absence of pronounced color, downward oblique direction, wide and strong diffusion, freedom from sharp and black shadows—these must be followed rather closely in ordinary artificial illumination or the eye that has been taking form

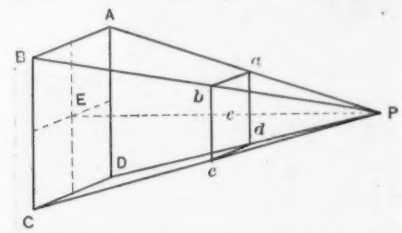


FIG. 2.—ILLUSTRATING LAW OF RADIATION.

through a million years of sunlight and skylight will resent the change. The eye is adjusted, it is true, for wonderfully diverse conditions, but persistent and grave changes in environment are more than it can bear.

Now from a practical standpoint the key to the situation is found in the thoughtful contemplation of what is known as Fechner's law, relating to the sensitiveness of the eye to visual impressions. It is stated by Helmholtz substantially as follows: "Within very wide limits of brightness, differences in the strength of light are equally distinct or appear equal in sensation, if they form an equal fraction of the total quantity of light compared. That is, provided the parts of the visual picture remain of the same *relative* brightness the distinctness of detail does not vary materially with great changes of absolute brightness. Now since, barring binocular vision, our whole perception of visible things depends upon differences of illumination in the absence of strong color contrasts, the importance of the law just stated needs little comment. It implies what experience proves, that within a rather wide range of absolute brightness of illumination our vision is about equally effective for all ordinary purposes.

Fechner's law, to be sure, fails when extremely brilliant lights are concerned. Few persons realize for instance that the sun is twice as bright at noon as it is when still 10 to 15 degrees above the horizon, still less that its brilliancy is reduced more than a hundred fold as its lower limb touches the horizon. Yet while the eye does not detect small changes or properly evaluate large ones in a body so bright as the sun, the mere fact that one can see to work or read about equally well from sunrise to sunset is most convincing as to the general truth of the law. Full sunlight at noon is generally over-bright for the eye if it falls directly upon the work, but with half of it one can get along very comfortably.

All this is most important from the standpoint of artificial illumination, since it means that within wide limits of intensity artificial lighting is about equally effective for most practical purposes.

The actual amount of illumination necessary and desirable, the terms by which we measure it and the laws that govern its intensity are matters of primary importance which must now occupy our attention.

A simple and definite standard of light is greatly to be desired, but we do not yet possess it. The practical and generally legal standard in English-speaking countries is the standard candle. This is defined to be a sperm candle weighing one-sixth of a pound avoirdupois and burning 120 grains per hour. Such a candle is a fairly steady and uniform source of light, and although less precise than would be desirable, has served a most useful purpose as a standard of light. From this a standard of illumination is derived by defining the distance at which this standard intensity produces a certain definite illumination, which forms an arbitrary unit. Thus one *candle-foot* has come to be a definite unit of illumination, i. e., the illumination given by a standard candle one foot from the object illuminated. Of course, it is entirely arbitrary, but it serves the practical purpose of comparing and defining amounts of illumination just as well as if it were a member of the C. G. S. system in good and regular standing.

A standard of illumination frequently used abroad is the *bougie-meter*, similarly derived with the meter as unit distance. This is sometimes known as the *lux*, but unhappily there is neither any convenient and practicable absolute standard of light nor any settled nomenclature of the subject, so that to save confusion the writer prefers to adhere for the present to *candle-foot*, which is at least specific, and bears a determinable relation to the bougie-meter (approximately the candle-foot equals eleven bougie-meters).

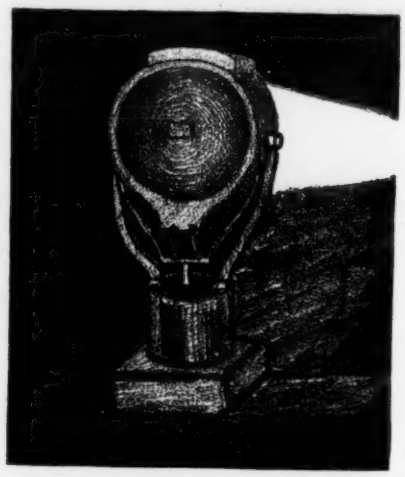


FIG. 3.—RAYS FROM SEARCHLIGHT.

For any light the illumination at one foot distance is obviously a number of candle feet numerically equal to the candle power of the light.

At distances other than one foot the illuminating power is determined by the well defined, but often misapplied, "law of inverse squares." This law states that the intensity of light from a given source varies inversely as the square of the distance from that source. Thus if we have a radiant point (*P*, Fig. 2) it will shine with a certain intensity on a surface *a b c d* at a distance *e P*. If we go to double the distance (*E P*) the same light which fell on *a b c d* now falls on the area *A B C D* of twice the linear dimensions and four times the area, and consequently the intensity is reduced to one-fourth of the original amount. Thus if *P* be one candle and *e P* one foot, then the illumination at *e* will be one candle-foot, and at *E* one-fourth candle-foot.

This law of inverse squares is broadly true of every case of the free distribution of energy from a point within a homogeneous medium for reasons obvious from the inspection of Fig. 2. It does not hold in considering a radiant surface as a whole, nor for any case in which the medium is not homogeneous within the radii considered.

By reason of these limitations, in problems of practical illumination the law of inverse squares can be considered only as a useful guide, for it is far from infallible, and may lead to grossly inaccurate results. It is exact only in the rare case of radiation from a minute point into space in which there is no refraction or reflection. A room with dead black walls, lighted by a single candle would furnish an instance in which the illumination could be computed by the law of inverse squares without an error of more than say 2 or 3 per cent., while a white and gold room lighted by a well shaded arc light would illustrate an opposite condition.

Fig. 3 shows how completely deceptive the law of inverse squares may become in cases complicated by refraction or reflection. Here one deals with an arc light of perhaps 10,000-cp as the source of radiation, but a very large proportion of the total luminous energy is concentrated by the reflector or lens system into a nearly parallel beam which maintains a very high luminous intensity at very long distances from the instrument. If the beam were actually of parallel rays its resultant illumination would be uniform at all distances, save as interfered with by the absorption of the atmosphere, probably not over 10 per cent. in a mile in ordinary clear weather, since the absorption of the entire thickness of the atmosphere for the sun's light is only about 16 per cent.

The searchlight is really a special case of scenic illumination, which generally depends upon the use of concentrated beams in one form or another so that one must realize that a very considerable branch of the art of illumination imposes conditions not reconcilable with the application of the ordinary law of inverse squares.

It is worth while thus to examine the law in question because it is a specially flagrant example of a principle absolutely and mathematically correct within certain rigid limitations, but partially or wholly inapplicable in many important cases.

Having considered the unit strength of light and the unit strength of illumination, the other fundamental of artificial lighting is the intensity of the luminous source—generally known as intrinsic brightness. Optically this has no very great or direct importance, but physiologically it is of the most serious significance, and perhaps deserves more thoughtful attention than any other factor in practical illumination. It is of the more consequence, as it is the one thing which generally receives scant consideration, and is left to chance or convenience.

By intrinsic brightness is meant the strength of light per unit area of light-giving surface. If we adopt the standard candle as the unit of light and adhere to English measures the logical unit of intrinsic brightness is one candle power per square inch. One then may conveniently express the brightness of any luminous surface in candle power per square inch and thus obtain a definite basis of comparison.

A Chapter on Electrical Instruction.

BY HARRY L. TYLER.

"THE method of instruction by analogues is always a dangerous one. . . . In the case of electricity, the danger is specially great when its etheric phenomena are illustrated with reference to phenomena of ponderable matter."—Editorial in ELECTRICAL WORLD AND ENGINEER, March 24, 1900.

If many electrical writers and speakers were to memorize the foregoing editorial before undertaking the instruction of the uninformed, much havoc would be undone. Contrary to popular belief, electrical science is by no means in its infancy. Yet many writers persist in the use of old phrases that sustain the popular fallacies rather than the unpopular facts; and the unwary reader that has been afflicted with them is quite likely to believe anything and everything that may be said of electric things. It seems to be the lot of many of us to labor over analogues, and then rest with the impression that electrification is—no one knows what!

In the early days of electrical science—and history shows that they were days when superstition was mightier than reason—the effects of electrification seemed indicative of some infernal fluid that was believed to flow through electrified bodies. Some investigators believed that there were two kinds of fluid—positive and negative—and that a union of both was necessary to a realization of either. Others believed in but one kind of fluid. These argued that quantities of the fluid lay normally at rest in some substances (silver, copper and the like) and that it did not exist at all in substances such as glass and rubber.

Thus was formed a great bugaboo—the table of conductors and non-conductors—which is still in press, notwithstanding that it is a misconception from beginning to end. Then arose the deplorable custom of teaching that "a current of electricity will flow from one body to another or from place to place in the same body if suitable means be provided to maintain the circulation by returning the electricity to its starting point."

In these days the falseness of either the two-fluid theory or the current-flow theory can not be overstated. Yet the current-flow

theory is continually appearing beside the picture of a water pump or an air pump with its outlet marked + and its intake marked —, as an illustration of what an electric generator is like. Instead of learning what electric generators, circuits and such things are like, or rather what people once thought they were like, let us learn what they are.

In his little experience of helping station men, railway men and the like in the study of electrical science, the writer has always kept in mind this golden rule: All words, terms and phrases that signify the transportation of something are misused if used at all in an electrical sense. Thus accordingly have been avoided these terms: resistance; hindrance; electromotive force; potential; pressure; tension; current; quantity; fluid; rate of flow. In following this policy no new words have to be coined. The simple little words ohmage, voltage and amperage are always preferable to any of the foregoing; and they lose none of their force in repetition.

In the making of any change there are involved three factors—persistence, effort and degree. Thus from an electrical point of view all matter has a persistence to stay unelectrified, which is called ohmage; in electrifying anything an effort to electrify is required, which is called voltage; when an effort is made to electrify anything the result is qualitative (not quantitative), and the degree of electrification is called amperage. The respective units are the ohm, the volt and the ampere.

In referring to circuits, dynamos, motors, meters and the like, we have reason to be careful of our diction. For instance, the propriety of the phrase "direct current" before any noun is questionable. The word "direct" is not, as many seem to think, opposed to the word "alternating." What is there that is not direct about alternating circuits? Surely the right word to use is "continuous;" for that is what we mean when we make the error of using "direct." As for the word "current," that is altogether superfluous in whatever place we use it in an electrical sentence. It is pleasing to note that several advertisers are omitting the word. How much better it is to read of "continuous dynamos;" "motors for continuous circuits;" "meters for alternating circuits;" "alternating arc lamps," and the like.

As far as electric "conductors" and "non-conductors" are concerned, we are unwarranted in speaking of such things. No substance is conducted through a body during its electrification, so electrified bodies are not "conductors." There is no substance that can not be electrified, so there are no "non-conductors."

Pole Climbing Contest at the Military Tournament.

What may be considered to be the electrical feature of the Military Tournament recently held at Madison Square Garden proved one of the most interesting events of the show. This consisted of a telegraph pole climbing contest between the members of the First Signal Corps N. G. N. Y., of New York City, and the Second Signal Corps N. G. N. Y., of Brooklyn, which was won by the First Corps, and a handsome trophy awarded by the Military Athletic League of America. This is the first time that the electrical end of signal work has been recognized in the annual military tournament. While the chief signal officer of the army has long maintained the superiority of trained electricians for signal work, it is only since the recent war that the New York State Signal Corps has fallen into line and taken up the study and development of telephoning and telegraphic communication to replace the old and obsolete visual signals, which, strange as it may seem, were considered very efficient. This is doubtless explained by the fact that in the past many National Guard signalmen considered line work and operation of electrical communicating devices very difficult, and believing war a very remote possibility, set themselves to the easier task of mastering visual signaling.

The chief signal officer's report of the Spanish-American war is interesting in this connection, as it is devoted almost entirely to the subject of electric signaling and points out how unavailable the visual signal proved, as it had to be practically abandoned for land work. In the Santiago, Puerto Rico and Manila campaigns, insulated wire was strung along the roadside and across country for several miles, and instantaneous communication maintained between all divisions almost without regard to distance, which permitted the unison of movements so necessary to successful military operations. At the outset of the late war the signal service was considerably hampered by lack of available trained electrical men and suitable material, but the signalmen of the State of New York are apparently guarding against this defect in the next emergency.

The Production of Asymmetrical Alternating Currents by Means of Electrolytic Polarization—I.

By W. L. HILDBURGH.

ALTHOUGH many asymmetrical conductors are known, none at present seem so well adapted to the purposes of scientific research and practical engineering as those operating electrolytically. No homogeneous asymmetrically conducting material has been found. This and a following article deal only with asymmetrical conductors whose action depends on counter e. m. fs. produced by electrolysis, some of them previously known, some original with the writer, and are a condensation of a thesis submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, in the School of Applied Science of Columbia University.* The lack of previous work on the subject and the large field to be covered have made it necessary to touch only on what have seemed the most important points, and to treat even those in a preliminary rather than a final manner.

Of the current curves taken from rectifiers in operation about half were read and plotted by Messrs. R. E. Slaven and H. K. McIntyre, to whom the writer's thanks are due for their earnest co-operation with him. The opportunity is also taken to acknowledge his indebtedness to Prof. M. I. Pupin and Dr. J. L. R. Morgan, in whose laboratories the work was carried on, for their interest and suggestions, and to the Crocker-Wheeler Electric Company and the Electrical Engineering Department of Columbia University, for apparatus loaned for the investigation.

The following terms are proposed, and will be employed throughout the paper:

An asymmetrically affected alternating current is one whose first and second half-waves represent different quantities of electricity.

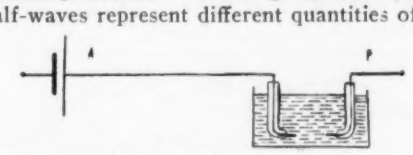


FIG. I.—TWO-CELL RECTIFIER.

The *asymmetrical efficiency* is the ratio of total to useful unidirectional current in an asymmetrical conductor.

A *two-cell rectifier* is an asymmetrical conductor, including one or several similar parts, each of whose parts consists essentially of two electrolytic elements.

A *single-cell rectifier* is an asymmetrical conductor, each of whose similar parts consists essentially of a single electrolytic element.

The *useful* part of an asymmetrically affected alternating current wave is the larger part. The *useful* current flows during the time represented by that part of the wave, and in the *useful* direction.

The *useless* part is the smaller part of the wave, and neutralizes a portion of the work done by the *useful*.

THE TWO-CELL RECTIFIER.

The two-cell rectifier appears to have been the earliest form of asymmetrical conductor operating, by the electrolytic production of counter e. m. fs., in a manner to warrant its introduction into practice. Its theory is simple, and readily forms a basis for a discussion of the theories of other types. The device consists of the combination in series of an active cell *A* (Fig. 1), and a passive, or polarization cell, *P*, whose plates are of limited area. *A* is any cell which will produce a current when applied to the terminals of a circuit; *P* a cell which is incapable of producing a current of itself, but which will give a counter e. m. f. when an active e. m. f. is applied to it in either direction. The active and passive e. m. fs. are preferably balanced, by making the active e. m. f. just less than the counter e. m. f. of the passive cell at the decomposition value, so that no current can flow on closed circuit without the application of an external source of e. m. f. A Daniell cell and a cell having water between platinized electrodes, for example, might be used.

If a direct e. m. f. be applied to the combination just described in a direction such that it aids the e. m. f. of the active cell, a direct current will flow as if neither active nor passive cell, neglecting their ohmic resistance, were present. If, however, the impressed e. m. f. be opposed to the active e. m. f. and less than the sum of the active and passive e. m. fs., equal to twice the active e. m. f., no continuous current can flow; when the impressed e. m. f. is great enough to

*To appear in full in *School of Mines Quarterly*, July and October, 1900.

cause a flow of current, that flow is produced by an e. m. f. equal to the difference between the impressed and twice the active e. m. f. Since in the opposite direction the effective e. m. f. is always equal to the impressed, an e. m. f. periodically changing in direction will cause more current to pass in one direction than in the opposite direction, the best effect being produced when the impressed e. m. f. is not greater than the sum of the active and passive e. m. fs. That is, a rectification of an alternating current will be produced.

The electrodes in a polarization cell form an electrolytic condenser and will act, until the decomposition value is reached, like an electrostatic condenser of the same capacity in series with a resistance equal to that of the cell would act. An electrolytic condenser differs from an electrostatic mainly in that its counter e. m. f., increasing with the impressed e. m. f. more or less uniformly up to a certain voltage (the decomposition value), then increases in a very much smaller, and decreasing, ratio, so that after the polarization reaches the decomposition value the cell discontinues its condenser action almost entirely and acts as a simple ohmic resistance in series with a counter e. m. f. As long as the polarization e. m. f. in a passive cell, due to the current through a two-cell rectifier, remains below the decomposition value the passive cell acts as a condenser. But when the decomposition value is reached the passive cell acts as an ohmic resistance with but little capacity in series with an e. m. f., by construction equal and opposed to the e. m. f. of the active cell.

Consequently, assuming that there is cessation of the condenser action at the decomposition value, the curve of a current produced by an alternating e. m. f. acting on a two-cell rectifier, will be composed of two parts; one in which a current flows due to the impressed e. m. f. acting through a capacity and a resistance in series, the other in which a current flows due to the impressed e. m. f. acting through an ohmic resistance alone. The shape of this curve, as shown by experiment and deduction, is largely dependent on the size of the passive plates and the relation of their capacity to the other constants of the circuit. The part which the condenser current plays in a two-cell rectifier was first recognized, so far as the writer knows, by Prof. M. I. Pupin. In 1894 he operated such rectifiers, at high frequencies, by using sufficiently small plates.

In the following deductions the action of the electrolytic condenser has, for simplicity, been assumed to be perfect. That is, it is supposed that no continuous current can flow before the decomposition value is reached, and that the polarization e. m. f. below the decomposition value is proportional to the integral current between the plates, and above that value is constant. Except within limits no one of these assumptions is correct, but undue complications are thus avoided and only minor modifications in the theory necessitated. The attainable polarization, and consequently the capacity, of platinum plates in dilute sulphuric acid depends largely on the state of their surface and on the current densities employed, and may be brought far above 1.67 volts (the generally accepted value for burnished platinum) under certain conditions. It has been assumed, in addition, that all the energy passing through the circuit goes to charge the condenser, though actually a large part is lost as heat. The capacity of an electrolytic condenser, per unit of area, is far greater than that of an electrostatic.*

If the first half-wave of current sent through the theoretical pair of cells forming the rectifier be produced by an e. m. f. in the same direction as the active its shape will be the same as that of the impressed e. m. f. If, however, the first half-wave of e. m. f. be in the opposite direction to the active the charged electrolytic condenser will be discharged to a degree dependent on the time and rate of flow of the current. The curve of discharge of a condenser, held charged by an active e. m. f., by an alternating current suddenly impressed upon its circuit is the same as its curve of charge from an uncharged state, other conditions being the same, and depends not only on the constants of the circuit—the resistance, capacity, self-induction and frequency of the impressed e. m. f.—but also on the value of the current which would flow after a state of rest had been attained at an instant corresponding to the instant of closing the circuit. It is the algebraic sum of the curve of current which would ordinarily flow and a logarithmic curve whose values are dependent on the strength which that current would have at the instant of "make."† The inductance, in the following, is assumed to be zero; its presence causes complications which will be mentioned later.

The second part of the curve, being that of a current through a re-

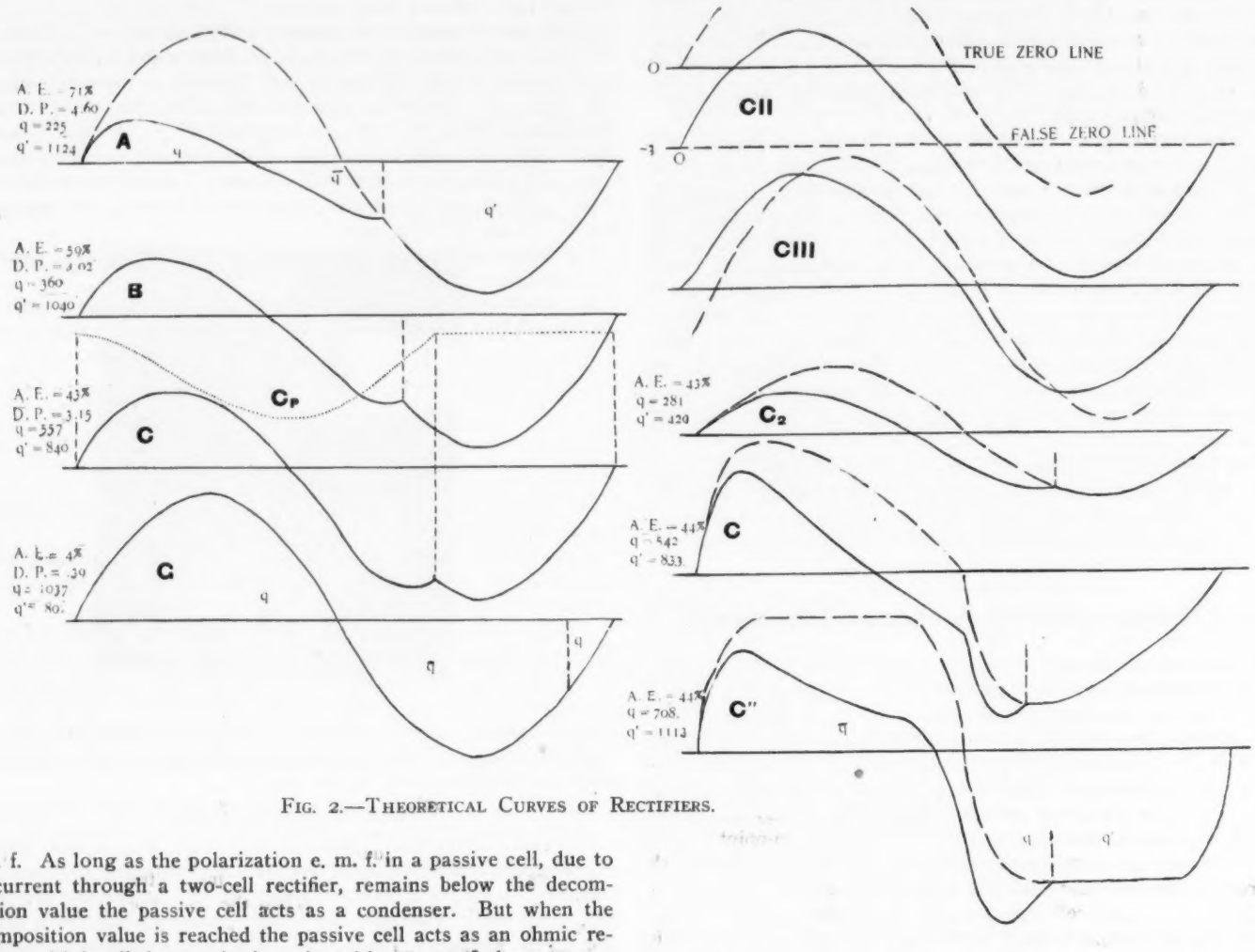


FIG. 2.—THEORETICAL CURVES OF RECTIFIERS.

*"Polarization by Alternating Currents," *Wied. Ann.*, 58, No. 1, p. 37. Also for change of capacity with frequency. "Polarization Capacity of Reversible Electrodes," Neumann, *Wied. Ann.*, 67, No. 3. "Polarization Capacity of Electrodes," Gordon, *Wied. Ann.*, 61, No. 1, p. 1. "Cathodic Polarization," Roszkowski, *Zeit. fur Phys. Chemie*, Vol. XV., 1894, p. 267. "Cathodic Polarization," Caspari, *Zeit. fur Phys. Chemie*, Vol. XXX., 1899. "Anodic Polarization," Glaser, *Zeit. fur Elektrochemie*, Vol. IV., p. 376, Feb. 20, 1898.

†Bedell and Crehore, "Alternating Currents."

sistance only, will have the same form and the same zero-point as the impressed e. m. f., the condenser remaining charged to the same potential throughout. The current curve is thus divided into a number of similar parts, each being of the same length, and having the same alternate zero points, as a complete e. m. f. period. If the active e. m. f. be too low a lead is produced; if too high, a lag. The complete curve may be separated into three divisions (see Fig. 2); one in which the condenser is discharging, one in which it is recharging, and one in which it remains fully charged and has no effect on the shape of the curve. The areas of the first and second of these divisions are evidently equal (assuming no loss of energy during the operation of the condenser), representing equal quantities of electricity taken up and given out by the condenser, and are the areas of the "useless"† part of the curve and the first part of the "useful." Calling the area representing this quantity of electricity q, and the remainder of the "useful" q^1, the total quantity of useful current in each period is $(q^1 + q - q) = q^1$, the total current of all kinds is $(q^1 + q + q) = (q^1 + 2q)$, and the ratio between those quantities, equal to $\frac{q^1}{q^1 + 2q}$, and termed the asymmetrical efficiency, is the efficiency of transformation. The frictional loss in the circuit makes the second q less than the "useless."

For the determination of the theoretical curves, *A* to *G*, a method of approximation based on the division of a period into a number of very small parts, in each of which the action is uniform and in accordance with the foregoing theory, has been employed. The results in each case can be shown to closely approximate the true form of the perfect curve. The broken line in *A* shows the form of the e. m. f. assumed; the curves *A, B, C* and *G* illustrate the effect of increasing either the area of the plates, the resistance of the circuit, or the frequency, each alphabetical step (*A-B, C-D*) representing a doubling of *one* of those quantities. The figures at the left of the curves give the areas of q and q^1, the asymmetrical efficiency, and the maximum decrease in polarization (*D. P.*) from the assumed original polarization of 5.00 volts. For *D* (not shown) $q = 762$, $q^1 = 542$, *A. E.* = 26 per cent., *D. P.* = 2.13; for *E* (not shown) $q = 926$, $q^1 = 411$, *A. E.* = 18 per cent., *D. P.* = 1.39. The dotted curve C_f represents the polarization of the passive plates in C. Curve *C* II shows the effect of increasing the active e. m. f. with respect to the passive, the conditions of area of plates, frequency and resistance being the same as in *C*. *C'* and *C"* show the effect of odd-shaped curves. In all the balanced *"C"* curves the asymmetrical efficiency is about 43 per cent.

In Fig. 3 are shown some curves of rectifiers in operation, plotted to various scales; *X* shows the zero-points of the e. m. f. The curves illustrated were taken from hydrogen-cell rectifiers, described in Part II., whose theory is the same as that of the two-cell rectifiers, and are common types. Lack of space forbids a presentation of the data obtained, although almost every point brought out in the "Conclusions" has been illustrated by curves. [*2MB(O)*] is the curve of a hydrogen cell unaided by an external direct e. m. f; the active e. m. f. is slightly too low. By adding .085 volts direct the cell is almost exactly balanced, the zero-points of current and e. m. f. coincide, and the curve assumes practically the theoretical form. [*2MAH*] shows the high rectification (95 per cent.) produced by a cell having an electrode .0507 sq. mm. area, at a frequency of 15½. [*3NBG*] illustrates one of the effects of inductance. The curves taken on hydrogen-cell rectifiers afford an excellent means of studying the progress of polarization of platinum in dilute sulphuric acid. About 160 curves on two and single-cell rectifiers were taken, of which approximately 120 have been utilized. The source of the alternating e. m. f. was a small bipolar rotary converter giving an e. m. f. having the third and fifth harmonics. In some of the curves the unchanged wave form was used; in the greater number the fundamental alone. During the curve tracing the conditions of frequency, resistance, temperature, etc., were maintained as nearly constant as possible. Great difficulty was at first experienced in taking the readings, due to the exceedingly small drop available, the maximum value in curves ranging from 1 to 1.5 volts (generally about .4 volts). The ordinary Mershon method with revolving contact was finally adopted, all connections being carefully insulated, and a very sensitive telephone used for detecting the point of balance. Balancing could be done and readings taken to within .001 volts.

The two-cell rectifier, as ordinarily constructed, consisted of a Leclanché in series with a decomposition cell containing acidulated (25 per cent. H_2SO_4) water between platinum electrodes. It was concluded that the e. m. f. of the Leclanché was too low for the passive e. m. f. The frequencies ordinarily used were 13½ and 15½ p. p. s. Curves were taken with frequencies about half and about double those figures. Current readings were taken at those frequencies and at frequencies ranging from 300 to 750 p. p. s., but no curves were traced; the action was found to be the same as at the lower frequencies.

The foregoing theory, with its reservations, having been shown by curves to be substantially correct, the following conclusions for theoretically perfect two-cell rectifiers, based on or verified by experiment in almost every instance, have been arrived at. They include only those considered the most important; the lesser ones, together with the methods of deduction, will be found in the unabridged paper.* The "efficiency" referred to is the asymmetrical efficiency, unless otherwise stated.

Conclusions.—The smaller the passive plates the higher the efficiency, other conditions being equal. For infinitely small plates the efficiency is 1.

The higher the total resistance the lower the efficiency. The internal resistance should be as small as possible, to keep the efficiency high and the C^2R loss low. There is a series of maximum values of the efficiency, one for each frequency, in any particular rectifier, which are reached only when there is no external resistance. If the external resistance be negligible, and all the current flow perpendicular to the plates, the efficiency is independent of the size of the plates, changing only with the frequency or the distance between the plates.

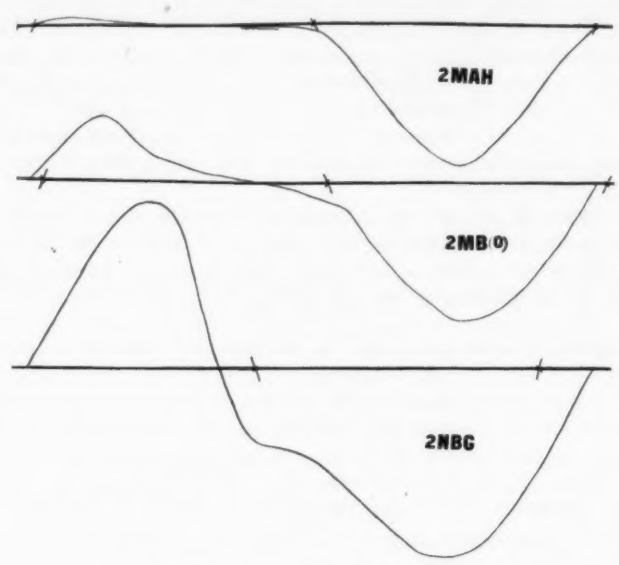


FIG. 3.—ACTUAL CURVES OF RECTIFIERS.

The higher the frequency the lower the efficiency, the efficiency reaching its maximum in any cell having plates of finite size only when the frequency is zero. When the frequency is very high in a theoretically perfect rectifier but little effect is produced; in practice the effect is enhanced due to the capacity of the passive plates becoming smaller as the frequency is increased.

If the active e. m. f. be increased the zero-line of asymmetry (the line representing the continuous current through the rectifier) will be shifted, and only the part of the "useless" projecting over the true zero-line will be choked, thus reducing the efficiency, though the amount of unindirectional current is increased. If the impressed e. m. f. be kept low asymmetry may cease completely.

If the active e. m. f. be decreased the capacity effect becomes more marked, reducing the efficiency. When the active e. m. f. is zero the efficiency is zero.

As long as the decomposition value is not exceeded in the passive cell the efficiency is independent of the impressed e. m. f. and of the shape of the e. m. f. wave. The quantity q^1, the direct current as read by an ammeter, is proportional to the impressed e. m. f. The larger the plates, or the greater the external resistance, the higher may be the impressed e. m. f. at any particular frequency. Other conditions remaining the same the higher the frequency the higher may be the impressed e. m. f.

†See introductory paragraphs.

*Sch. of Mines Quar., July and Oct., 1900.

The higher the frequency, other conditions remaining the same, the greater the quantity of direct current, as read by an ammeter, obtainable from a rectifier. The larger the plates the greater the quantity of direct current obtainable, other conditions remaining the same. The efficiency, however, is lowered by increasing either the frequency or the size of the plates.

The higher the decomposition value the higher may be the impressed e. m. f. per rectifier. If the decomposition value is not overstepped in the "useless" direction its size has no effect on the efficiency. The asymmetrical effect is independent of the maximum separate potential difference attainable at either passive plate.

If one of the passive electrodes be greatly enlarged its ability to rapidly change the potential difference at its surface is lost, and it obtains a constant charge equivalent to a certain active e. m. f. When the larger plate, in dilute H_2SO_4, is connected to the negative pole of the active cell the efficiency is higher than when it is connected to the positive pole. If the larger plate has an infinite capacity the capacity of the electrolytic condenser becomes that of the smaller plate.

The surplus gases at the passive electrodes should be instantly discharged for the best results to be obtained. The electrolyte should be free from traces of a salt of a metal not readily oxidizable and which may be deposited. An electrostatic condenser cannot be used in the place of the electrolytic, nor in series with a rectifier.

Inductance in series with a rectifier generally decreases the efficiency by increasing the area of the "useless" and by choking the "useful;" under certain conditions it increases the efficiency.

The commercial efficiency of a two-cell rectifier is equal to the product of the asymmetrical efficiency and the ratio of the work in the external circuit to the losses in the rectifier. It is 100 per cent. only when the current is direct and the internal resistance negligible. There is, for each frequency, a particular size of plates when the external resistance is kept constant, or a particular external resistance when the size of the plates is kept constant, at which the commercial efficiency is a maximum.

The active cell will be wasted by doing a certain part of the work in the circuit, represented by the energy contained in the bubbles from the passive plates. The lower the impressed e. m. f. the smaller the proportion of the total work in the circuit done by its source.

Rectifiers for high impressed e. m. fs. may be formed by joining a number of two-cell rectifiers in series. If n rectifiers are put in series and the passive plates in each made n times as large as before neither the internal resistance nor the efficiency will be changed, though the ability to asymmetrically affect an alternating e. m. f. n times as great as at first has been gained. If n rectifiers are put in series without changing the size of the plates the efficiency will be the same as in a rectifier having plates $\frac{1}{n}$ the size of the plates in each. The number of rectifiers and the impressed e. m. f. should, for the best result, be proportioned to their circuit as primary cells are proportioned, each primary cell being represented by a rectifier and a certain fraction of the impressed e. m. f.

In a succeeding article some single-cell rectifiers will be described.

CURRENT NEWS AND NOTES.

COL. POPE, PROPHET.—According to a Boston despatch, Col. A. A. Pope predicts that "within twenty years our cities will ask for legislation to prevent horses from coming into the city at all."

AUTOMOBILES FOR THE ARMY.—One of the innovations in military transportation which was brought about and developed largely through our war with Spain is the use of the automobile. The signal corps of the American army has recently been supplied with electric automobile wagons for use in the Philippines. These wagons are of two kinds, one to carry the instruments and material and the other to carry the personnel. The first is built like a covered ambulance, with rubber-tired wheels, and contains a storage battery capable of running the vehicle for thirty hours on one charge when carrying 1500 pounds of load. There are two 3½-hp motors, one in each rear wheel. The maximum speed is about ten miles an hour. The other wagon is constructed like a high cart and is in other respects similar to the first. Both wagons are fitted with electric side lights, and the first also has electric lights in the interior. Other military applications of the automobile have been considered by the military world, but this is the first actual introduction.

THE NEW YORK ACADEMY OF SCIENCES will hold its annual reception and exhibition of recent progress in science at the American Museum of National History, New York, on April 25 and 26. On Wednesday evening, April 25, there will be a reception to the members of the Academy and their invited guests, while on the following day the exhibition will be open in the afternoon for students and others, and in the evening there will be a reception for the members of the Scientific Alliance. The exhibition will be divided into sections. The electricity section will be in charge of Prof. George F. Sever, who has secured the co-operation of the General Electric Company, the Westinghouse Company and Queen & Company, with a result that considerable new apparatus will be put on exhibition. Prof. Pupin, of Columbia, will also show some new instruments of his own design.

THE AUTOMOBILE RACE AT THE PARIS EXPOSITION.—The automobile contests which will take place at Paris during the exposition period is exciting much interest. The speed contests will take place in July. In the contest between carriages there will be nine cash prizes, aggregating 30,000 francs. The first prize will be 8000 francs; the second prize, 6000 francs. In the contest between small carriages there will be seven prizes, aggregating 9000 francs, the first prize being 4000 francs. In the contest between motocycles there will be thirteen cash prizes, aggregating 8000 francs, the first prize being 2000 francs and the second prize 1500 francs. The contest between lightweight automobiles will take place in September. The programme will include a contest of automobile cabs and delivery wagons capable of carrying loads of 1200 kilograms in weight. United States Commissioner General Peck has taken great interest in these automobile contests and will offer every facility for American visitors who desire to witness them.

EIGHTY-MILE TRANSMISSION IN CANADA.—The announcement is made that the Shawinigan Water & Power Company will transmit the power which it has developed at Shawinigan Falls, to Montreal. The company will, early in the coming summer, complete the works which it has had in process of construction during the past year. These works consist of a canal and the necessary flumes, etc., in order to develop 30,000-hp, and the construction is such that this amount of electrical power can easily be increased to 75,000-hp. It is not, however, the purpose of the company to deliver the power in Montreal until the spring of 1901. The transmission line will be a little less than 80 miles in length, and it will run along the Great Northern Railway to Joliette. From Joliette the line will run in an air line to the end of the Island of Montreal, coming into that city by the most direct route available. The loss in the eighty-mile transmission will be reduced to a minimum by the adoption of the modern and most improved methods of electrical transmission. By reason of the low cost of development at Shawinigan Falls, the company will be able to deliver power in Montreal at prices most advantageous to the consumer. At the outset 5000-hp will be delivered in Montreal which will be increased as may be required.

STORAGE BATTERIES.—Four storage battery patents are included in the budget of April 3, of which two were issued to E. A. Sperry and one each to H. J. Cogswell and G. W. Gesner. One of the Sperry patents describes an envelope or separator for plates to retain the active material without interfering with the action of the cell. The separator consists of a mat formed by a layer of pyroxylin between two non-woven layers of cellulose. The pyroxylin is in the form of a fabric of which the warp and woof are dissimilar as to coarseness and weight. The second Sperry patent relates to means for arranging plates so that active material may not drop out. This consists in the use of a fibrous, ribbed envelope with the ribs in contact with the electrode for the purpose of not only catching and holding any material which tends to disintegrate from the surface, but also to give better circulation to the electrolyte. The plates and their fibre envelopes are spaced by hard rubber or celluloid which is corrugated and perforated, and each plate is independently supported. The Cogswell patent describes a battery made up of parallel cylindrical electrodes, those of one sign being in contact relation with, say, an upper plate, and insulated from a lower plate, and vice versa. The electrodes are made up of an antimonial lead core united to which is a soft lead jacket. Grooves are then cut in the latter and filled with active material. The Gesner patent describes a cell, the case of which is of an alloy of iron and hydrogen. The electrodes contained within the case consist of plates of the same alloy and having lead active material applied to them.

MR. CARL HERING has received an appointment from the government to act as a member of the Paris Exposition Jury of Awards in the class of electricity.

THE SMOKE QUESTION IN DENVER.—The smoke ordinance in Denver, Col., has been declared unconstitutional on the ground that no device exists for the adequate prevention of smoke, as provided by the ordinance.

LOCOMOTIVE ELECTRIC HEADLIGHTS.—The Northern Pacific Railroad is placing electric headlights on those engines which handle the through coast trains. The cabs are wired for several 8-cp incandescent lights to be placed in front of the various gauges. Ten lights of the same power are distributed on the under side of the running boards and under the boiler, to be used when oiling. These latter are expected to be of great convenience when the wind makes it difficult to keep a torch lighted. Both incandescent circuits are taken directly off the brushes of the small series generator which supplies current to the headlight.

CONVENTION OF NATIONAL ASSOCIATION OF MANUFACTURERS.—The fifth annual convention of the National Association of Manufacturers will be held in Boston on April 24, 25 and 26. The final feature of the convention will be a banquet tendered by the citizens of New England, to which the co-operation of the New England Cotton Manufacturers' Association, the National Association of Wool Manufacturers, the New England Shoe and Leather Association and the American Paper and Pulp Association will be invited. It is expected that President McKinley will be the guest of honor on the occasion, and the Chinese Minister, the Russian Ambassador, Hon. J. D. Long and other men of note in public life will be present.

COPPER MINING.—In a lecture recently delivered by Dr. A. R. Ledoux, before the New York Electrical Society, entitled "Copper from the Ore to the Wire Bar," some interesting data were given concerning the production of copper. In the period from 1895 to 1899 the lake product increased 13,000 tons, the Montana product almost 25,000 tons, and the Arizona product about 37,000 tons. The totals for these several localities were 77,500 tons, 114,500 tons and 61,000 tons respectively for last year. The Lake Superior ores contain less than 4 per cent. of copper, and those of Montana about 6 per cent., while the Arizona ores yield up to 33 per cent. of copper. In 1899 the copper production of the world increased 50,000 tons and the consumption nearly as much.

ELECTRIC RAILWAYS IN SOUTH AFRICA.—Referring to the street railways of Johannesburg, South Africa, United States Consul General Stowe in a recent communication to the State Department, says that "in Johannesburg the same style of cars are used as in Kimberley, the government having refused to grant concessions for the building of an electric line for the reason that the farmers would lose a sale of forage (oats and straw). Even a bicycle is objected to for the same reason and a heavy tax is placed on it." Mr. Stowe reports that electric lines have recently been constructed in East London and the same are about to be installed in Durban and in Kimberley. There are already electric lines in Cape Town and Port Elizabeth, built by American mechanics and supplied from the United States.

THE NEW COMMERCIAL CABLE.—Mr. S. S. Dickinson, superintendent of the Commercial Cable Company at Canso, N. S., has gone to the Island of Fayal, in the Azores, to arrange for the reception of the company's German cable, which will land there. When completed, the cable will make a direct connection between New York and Germany. Six hundred miles of this cable has just been completed off the coast of Nova Scotia, and the object is now to begin paying out the cable from the Island of Fayal and running northwestward until a connection is made with the part referred to off the Nova Scotia shore. The steamer Faraday is now on her way to England, where more cable will be taken on, which will be used in making the connection. It is expected that this new link of the Commercial Cable Company will be completed in about three months' time, and, when finished, will make the fourth cable belonging to this company which crosses the Atlantic.

UNIVERSITY OF NEBRASKA.—On March 21 and 22 Mr. Edward P. Burch delivered to the University Society of Electrical Engineers two lectures upon the utilization of water power in the electric railway system of the Twin Cities. These lectures were illustrated, and showed how a new dam was built across the Mississippi at Minneapolis developing 10,000-hp through horizontal turbines directly connected to ten 1000-hp generators. The power is transmitted to substations from three-phase generators by means of small underground cables exclusively, the longest being a ten-mile line to St. Paul. The converters and switchboards at the substations were described, and the speaker closed by showing how closely the modern heavy traffic of city railways is following steam railroad practice in matters of speed and of train despatching, and he predicted the rapid extension of electricity in the service of our steam railways.

HIGH VOLTAGE TRANSMISSION LEAKAGE.—In a paper read before the Chicago Electrical Association, Mr. Budd Frankenfeld pointed out that while mathematical analysis shows that the three-phase system of electric power transmission is the most economical, this does not hold when the working limit of voltage is approached. The two-phase, four-wire system with interconnected apparatus has six leakage paths—two at the limit of pressures and four at 71 per cent. of this pressure; the three-phase system has three leakage paths, each at the limit of pressure; the two-phase, four-wire system with independent circuits has only two leakage paths, both at the limit of voltage, while the single-phase system has but one path, that the limit of voltage. Considering the above systems from this standpoint, the single-phase has the greatest advantage, the two-phase system with independent circuits coming next, and for the third place there is but little difference between the three-phase and two-phase interconnected systems.

INDUSTRIAL DEVELOPMENT IN SIAM.—In a recent communication to the State Department Mr. Hamilton King, Consul General at Bangkok, Siam, gives an interesting account of industrial development in that country. Rice cultivation is the principal industry of Siam. All but four of the mills are owned or managed by Chinese. Seven of the mills are equipped with electric light plants, one of which was furnished by an American house. All the other supplies and the rice milling machinery have come from England and Scotland. The next industry of importance is teak wood. Three of the mills have their own electric light plants, and all of them get their machinery and supplies from Great Britain. Street transportation in Bangkok offers opportunities for the introduction of the different styles of light running American vehicles. These, the consul general states, would prove very desirable if once introduced. The streets are perfectly level and the pavements are most adaptable to the use of light-running vehicles of all kinds. The workmanship and material, Mr. King says, must be first class to meet the climate, which changes very quickly from extremely wet to hot and dry; but if well made, there is no doubt that American vehicles would wear quite as well as the cumbersome ones now in use, while their greater lightness and beauty would win for them a place in this market.

THE INDUSTRIAL DEVELOPMENT OF PUERTO RICO.—A correspondent of the New York *Times* directs attention in a letter from San Juan, Puerto Rico, to the industrial opportunities now offered in that new possession. He says the existing railways on the island are almost useless as a means of bringing agricultural products to market. Engineers have been considering a plan for utilizing the power of some of the rivers that reach the coast for the installation of electric railway lines over which products may be carried from interior points to harbors for shipment. At Arecibo 1500-hp may be developed, the Cameno River may develop 1200, and the Luiza 1500. The plan seems feasible, he says, and its commercial value would depend upon interior road development. Whenever by any means the productive regions may be brought within easy distance of interior depots for shipment, electric lines would doubtless be assured a paying business in carrying products to market in one direction and in taking back provisions and general supplies in the other. An electric system would be cheaper in all respects than a system of steam railroad lines to the interior, both because of the initial cost of construction and of the cost of maintenance, coal being scarce and dear. Besides, the railroad experience already had would argue strongly against extending steam railroad rights, were there no other obstacle.

A CHILIAN ELECTRIC RAILWAY OPENED.—A despatch from Santiago de Chili states that the first electric street car ever operated in that city passed over the lines on April 1.

THE AUSTIN POWER HOUSE WRECKED.—The flood in the Colorado River carried away the second power house of the big dam at Austin, Tex., on April 8, causing a loss of $500,000. The wrecking of the dam has left the city without light or water.

THE ELECTRICAL CONTRACTORS' ASSOCIATION of Allegheny County met on April 6 and discussed the subject of price lists. The list as adopted makes an advance of 25 per cent. over the old prices, but it said to be still 75 per cent. lower than the prices promulgated by the combination of electrical supply houses. The question of holding a national convention of contractors was again spoken of, but the matter was laid over for one week.

ELECTRICITY FOR COKE WORKS.—At the Paul Coke Works of the W. J. Rainey Coke Company, Connellsville, Pa., an electric plant is now being installed which is attracting the attention of the coke workers generally, because it has for its object the charging and discharging of coke ovens by electric power. The plant will have a capacity of 200-hp. A trolley line will be constructed along a line of 500 coke ovens, and instead of the mules, two motors will be operated. It is expected that electricity will effect a great saving of time and money.

TRANSFORMER WITH TUBE SECONDARY WINDING.—A patent issued April 3 to W. S. Moody describes an arrangement for cooling transformers in which the secondary consists of tubes through which a circulation of cooling fluid may be maintained. The primary winding is wound and insulated in the usual manner. It preferably consists of sections between which are located the secondary element, which consists of drawn-copper tubes of flattened shape connected to form a continuous circuit. Both primary and secondary are submerged in oil, and the heat extracted from the latter by a cooling liquid circulated through the secondary.

SWINDLERS SENTENCED.—Several months ago a band of swindlers was arrested in Georgia which had victimized many manufacturers throughout the United States. The scheme was to order goods to be shipped to Glenwood and other places on the Georgia, Alabama & Central Railroad. The goods were then reshipped to other points and disposed of at low prices. Among the victims was a western telephone manufacturing company which found upon investigation that a Georgia telephone line had been largely constructed from material fraudulently obtained from it. Recently the ringleader, Tyson, was sentenced to the penitentiary for five years and ten others in the conspiracy for periods of from six months to three years.

NICKEL ELECTROPLATING.—In a paper read before the March meeting of the Chicago Electrical Association, Mr. C. F. Burgess referred to a solution of the difficulty of obtaining a thick layer of adherent nickel by electroplating. A peculiar molecular strain is set up within the nickel while being deposited, which reaches such a value when a certain thickness is reached that the layer will detach itself from the iron or other metal surface, or be easily removed by subsequent polishing. In the electrochemical laboratory at the University of Wisconsin experiments have been made in depositing nickel from the ordinary plating solution and under the ordinary conditions with the exception that an alternating current is passed through the vat in addition to the usual direct current. It was found that this had a marked influence on the character of the deposit, it being possible thus to obtain a coating as thick as desired.

CARBON BRUSH.—In 1895 two patents were issued to Prof. Elihu Thomson on types of carbon brushes, one of the patents showing strips or small pieces of carbon plated with metal and united by soldering or sweating into a mass; and the other showing brushes made of carbonized fibrous material, having a certain resilience and united at one end, the fibrous material being free at the end next the commutator and plated with metal so as to insure sufficient stiffness and resilience and retain high longitudinal conductivity. A patent issued April 3 to Prof. Thomson relates to the same class of brush and aims to combine in a single structure the advantages possessed by the two different devices above referred to. For this purpose, thin plates of carbon, each plated with a conducting metal such as copper, are clamped in a suitable brush holder and individually bear against the commutator in the usual way. Each plate is free to slide in adjusting, and the clamping does not impair the individual resiliency of the different carbon laminations. The brush can be used on machines of moderate or low potential without undue loss of potential due to the high specific resistance of the carbon, while the short circuiting of the coils at the commutator is effected through a high resistance.

MUNICIPAL ELECTRIC LIGHTING AT PETOSKEY, MICH.—The Independent Democrat, of Petoskey, Mich., gives an account of municipal ownership in that town which shows that the long list of municipal central station failures has received another addition. When the municipal craze struck the town an appropriation of $8000 was made to erect a municipal plant, this amount being considered sufficient for the purpose, but finally the private lighting plant was bought for $16,000. Very soon after $12,000 were appropriated for improvements in the plant. *The Independent Democrat* refers to subsequent events as follows: "What is the result of the confidence placed by the people who voted in favor of bonding? Not only have these honorable city officials 'dumped' all the profits of the plant into it, but they drew $900 from funds other than the electric fund, and overdrew the electric fund $600 as shown by the Grand Rapids expert's report, while the city is over $10,000 in debt for loose accounts, besides showing an unaccounted 'shortage' of over $2000! Out on the Charlevoix road and on Emmet Street have stood for the past year, and are there to-day, wireless poles—monuments to the inefficiency, negligence and mismanagement of the council and board of public works."

ELECTRIC DEVELOPMENT IN BRITISH GUIANA.—Mr. C. H. Cahan, of Halifax, N. S., has just returned from British Guiana and Trinidad, where he has been for some time in the interests of a Montreal and Halifax syndicate, incorporated as the Demerara Electric Company. The company has obtained in the colony of British Guiana exclusive electric lighting, power and tramway franchises for the city of Georgetown and its environments within a radius of five miles. The company has purchased all existing electric light plants and mule tramways in the city and is now completing the installation of electric traction on the tramway, which will be fully accomplished by the 31st of July next. The electric light plant has been under the new management about three months, and in that time its operation alone, independent of the tramway, has shown a net profit that will pay the interest on the bonds and give 2½ per cent. on the entire capital stock. Mr. Cahan was also at Port of Spain, Trinidad, advising as to tramway and electric light legislation which is being obtained in the interests of a number of the same gentlemen composing the above company. These have become incorporated as the Trinidad Electric Company, with a capital of $1,250,000. Contracts have been made there for the purchase of existing electric light interests and mule tramways.

OPPOSITION TO DEVELOPMENT OF CANADIAN WATER POWER.—The Cataract Power Company, of Hamilton, Ont., was empowered by the Ontario Legislature, in January, 1898, to develop electric power in the vicinity of the Welland Canal. The company proceeded to construct hydraulic works at Decew's Falls and to build a transmission line to Hamilton, and the company is now supplying power to various concerns in that city. Hon. J. M. Gibson, Attorney General of Ontario, is president of the company. The city of St. Catherines, Ont., is seeking to acquire water privileges within its corporate limits, or in the counties of Lincoln and Welland, within a radius of five miles of St. Catherines, with sufficient lands for the proper use of such privileges and the erection of buildings for manufacturing purposes, also for generating and transmitting electric power to points in or near the city. St. Catherines is situated in the centre of a great water power. The city has a bill before the Ontario Legislature to authorize it to develop the energy that is running to waste at its doors, and to convert it into mechanical power. It seems, however, that the passage of this bill would create a formidable rival to the Cataract Power Company, and therefore there is strong opposition on the ground that it would convert St. Catherines into a financial corporation.

Letters to the Editors.

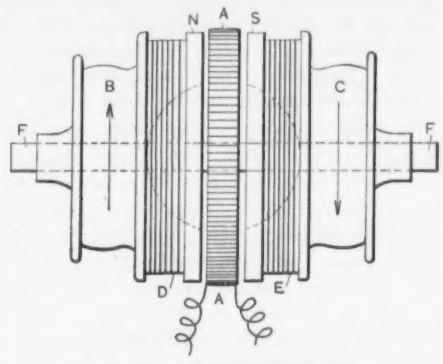
Commutatorless Dynamos.

To the Editors of Electrical World and Engineer:

Sirs:—I have read in your issue of Sept. 9, 1899, a communication by Mr. James Asher on unipolar dynamos, and your editorial comment upon it. The well-known disadvantage of the unipolar dynamo is the very low tension of current it produces. All the methods that have been experimented with to remove this objection have failed from the impossibility of a series connection between the various inductors moved before a polar face, for the reason that the conductor which would have to be used to connect the two inductors with each other will itself become an inductor; and being joined to oppositely situated ends of two adjoining inductors will neutralize the e. m. f. produced in a length of inductor equal to its own length. I have for a long time searched for a method to obviate this difficulty, and I have finally arrived at one which may be of interest to the readers of your journal.

It can be easily seen that if the two faces of a flat ring having a continuous convolution of insulated wire are rotated in opposite directions between two polar faces of different sign, and in such a manner that the magnetic circuit will pass from one face to the other laterally through the ring, then, owing to the two opposite movements of the polar faces, the induced currents in the adjacent radial wires must be directed in one side from the circumference to the centre and in the other side from the centre to the circumference.

In this manner all the currents generated will aggregate to produce a continuous flow of current at any potential. The accompanying sketch will give a clearer view of the idea. In it *A* is the inducing iron-cored ring; *N* and *S* are the two polar faces, north and south respectively; *D* and *E* two exciting coils; *B* and *C* are pulley faces and *F* an iron shaft which passes through the ring and completes the magnetic circuit.



COMMUTATORLESS DYNAMO.

Albert Griene.

Lima, Peru.

DIGEST
OF
Current Electrical Literature.

By CARL HERING.

Dynamos, Motors and Transformers.

Boudreaux Brushes.—Langbein.—An article describing experiments which prove that the Boudreaux foil brushes made of antifriction metal, although excellent for dynamos with a pressure on the terminals of 4 volts or more, should not be used for dynamos of lower voltage, as the resistance of the brushes themselves, as well as that of the film produced upon the collector, is too great to be overcome easily by current of lower voltage. The heating of the collector and the decrease of voltage and current, observed on 2-volt dynamos with Boudreaux brushes of antifriction metal, are caused not by a bad design of the dynamo, but by the excessive resistance of the brushes, as explained.—*Elek. Zeit.*, March 22.

REFERENCES.

Converter.—An illustrated description of a converter, devised by Legros and Meynier, for transforming continuous current of 110 volts, to a lower voltage for charging three, four of five-battery cells. The armature has two windings, one drum wound for 110 volts and the other having only one turn and a two-part commutator. The results of tests are given in two tables, and the machine is said to be very practical for charging cells.—*L'Elec.*, March 10.

Dynamo Design.—E. K. Scott.—The conclusion of his illustrated article on some mechanical details of dynamo design (Digest, March 24). He discusses methods for fixing driving horns, for insulating the corners of armature cores, for cutting out end strip connections for bar armatures, and for making joints for end connections.—Lond. *Elec. Rev.*, March 16.

Steam Dynamos.—An illustrated description of two generating sets, recently installed in Hull for electric traction. The dynamo is designed for an output of 460-kw at 270 r. p. m., the pressure being 2250 volts.—Lond. *Elec. Rev.*, March 16.

Lights and Lighting.

Incandescent Lamps.—Willcox.—The first part of a very long, illustrated Franklin Institute paper, giving a full account of the more important and interesting features of the methods used at present in the manufacture of incandescent lamps. He first discusses improvements in lamp manufacture: making the filament, treating or flashing the same, joining it to the conducting connections, and exhausting the lamp. By the subdivision of processes, limiting each distinct operation to one set of operators, by constant systematic inspection and testing following each operation, manufacturing results have been made far more exact. He then discusses the improvements in quality. The quality of 100 to 125-volt lamps has been advanced very close to the naturally better quality of the 50-volt lamp, so that the large difference in results and performance between 50 and 100-volt types no longer exist; this with the better distribution afforded from 100-volt secondaries, and better regulation obtainable with larger transformers, is rapidly causing the displacement of 50-volt lamps. Recently 200-250-volt lamps have been very successful, over 400,000 being now supplied annually; the limitation to their use is their low efficiency, which is 4 watts per candle or lower; they stand about half way in "results given" (presumably meaning life) between the 3.1-watt and the 3.5-watt 100 to 125-volt lamps; this difference of 0.7-watt per candle, or 22 per cent. more power than the 100-volt lamp for same "results," weighs against the lamp, and the better distributing advantages of the 200-volt system have not been sufficient to cause a change as yet in the large direct current central station; it is to be expected that with increased demand for high voltage lamps concentrated skill and attention will improve their quality. A 3½-watt 200 to 250-volt lamp is practicable, but the conditions are not ripe as yet for marketing it. The greatest advance has been made in the efficiency; the early 3.1-watt lamp had an average efficiency of 3.8 watts per candle, while that of the present lamp is 3.25 watts; this has been accomplished not only by improvements in manufacture, but also by the education of lighting companies to renew the lamps frequently instead of permitting them to burn until broken. Close and uniform rating is one of the chief essentials for a lamp; the leading American companies are to-day rating their lamps by the English parliamentary standard, taking the mean horizontal candle-power of each lamp when rotated, at about 180 revolutions per minute. The leading makers now photometer each lamp. As to the so-called standard voltages, he says customers who remain at such voltages as 110 or 220, will invariably get the poorest lamps of whatever make they may purchase; there are more than three times as many "110-volt lamps" used to-day than are made. Ceneral station managers should change their voltage to some special point, as 107 and 108, or 113 and 114, 117 and 118, 122 and 123, 208, 212, 230, 240, etc.; such changes can be made and have been made with comparative ease, even on the largest installations. The

standard lamp of this country is the 16-cp lamp, in Europe the 8; in the last years the demand for 10, 8, 6, 4-cp lamps has grown very large; the difficulty is that an 8-cp lamp cannot be made which at the same efficiency gives results equal in either life or maintained candle-power performance to the 16-cp, which is due to the thinner and more delicate 8-cp filament; the useful life of an 8-cp lamp is now not much below 100 hours short of the 16-cp lamp, under perfect voltage conditions. There are in use in this country now only three bases, the Edison, Thomson-Houston and Westinghouse; the tendency is strongly towards a still further reduction to one, i. e., the Edison; the only real objection to the latter was the live contact exposed by the portion of the shell part of base extending outside of socket, which has been corrected by shortening the shell, so that the socket entirely covers the base. The use of porcelain marks the greatest improvements in bases. In a diagram he gives two curves, showing the candle-power performance by hours of burning for the early 3.1 lamps and the present lamp of the same make; the former reaches 80 per cent. of 16-cp at 200 hours, the latter at 450 hours. As to the future delivery system, by which the customer places his order for his year's needs, specified as to types desired, with the manufacturer, and gets the lamps during the year as he needs them, he says that it is the mainstay of the lamp business to-day.—*Jour. Frank. Inst.*, April; also ELEC. WORLD AND ENG., Jan. 6, 1900.

Nernst Lamp.—F. SCH.—A continuation of the illustrated article, abstracted in the Digest March 24. In a lamp of the General Electric Co. of Berlin, the automatic electromagnetic cutout is placed in the socket and protected from the heat; in its general appearance it is quite similar to the ordinary incandescent lamp. The American patents of Fessenden are described, with illustrations; also two automatic electromagnetic cutouts patented by McLagan, in the first of which are two U-shaped electromagnets, with poles opposite to one another, and an armature oscillating between them for making different contacts. When the lamp is switched on, the current goes through the winding of the first electromagnet and the heating body of the lamp; the first electromagnet is thus excited and attracts the armature, closing a contact which connects the incandescent body in parallel to the heating body. In series with the incandescent body is a second winding of the first electromagnet, which is wound opposite to the first winding; in this position of the armature the winding of the second electromagnet is also in series with the incandescent body and the second winding of the first electromagnet. When the incandescent body is heated and becomes conducting, a current passes through the winding of the second electromagnet; the first electromagnet is thus demagnetized and the second is excited and attracts the armature; in this way contacts are broken and others are closed so that the heating body and both windings of the first electromagnet are out of circuit and the current passes through the windings of the second electromagnet and the incandescent body; at the same time a resistance is automatically connected in parallel to the windings of the second electromagnet, so that only so much current passes through the latter, as is necessary to hold the armature in the required position. It is said that this device can be modified so that only one electromagnet is required. A similar device for three incandescent bodies and one heating body is also described and illustrated. In the preparation of those which do not consist of simple oxides of metals, but of a mixture of several oxides, it is difficult to obtain homogeneous incandescent bodies; when dry powders are mixed, it is hardly possible and requires a comparatively long time; the General Electric Company of Berlin therefore prepares them by mixing the solutions of the salts of the respective metals, then evaporating or precipitating with alkalies or by electrolysis, thus producing a dry, intimate mixture from which, by heating, a very homogeneous compound of the oxides is obtained.—*Elek. Anz.*, March 18.

Electrolytic Incandescent Bodies.—RASCH.—An abstract of a paper read before the Polytechnical Society in Munich on the preparation of electrolytic incandescent bodies for experimental purposes. Fifteen per cent. of nitrate of yttrium, dissolved in water, and mixed with 85 per cent. of oxide of zircon, are ground to a very fine powder and heated until all nitrogenous vapors disappear. The resulting powdered substance is mixed with gelatine and pressed or "squirted" into tubes under a pressure of 3000 atmospheres, after which they are fired and hardened. Such a tube is then placed between electrodes and sparks are made to pass over it, heating the walls of the tube in two to three seconds, so that it becomes conducting; a separate heating device is therefore superfluous.—*Elek. Anz.*, Feb. 25.

POWER.

Electric Driving for Machine Shops.—A note stating that all experience thus far with electric power for shop service has gone towards establishing the fact that electric motor installations are money savers. In the Baldwin Locomotive Works of Philadelphia with electric motors in service of 3100-hp, the generator capacity provided is only 1550-hp, and of this a 250-hp unit is kept in reserve. One-third of the rated motor capacity may usually be ample for the generator capacity in large plants; according to another author one-sixth has been found sufficient; these proportions obviously require qualification for different conditions.—*Cassier's Magazine,* April.

Electric Haulage.—A description of the system of electric haulage used at the Norton coal mines, Virginia. An electric locomotive of the Baldwin-Westinghouse type is used, and is illustrated. The output of the mine has been about doubled by the introduction of electric traction; at the same time the cost of hauling has been reduced from 8 cents per ton to 1 cent, to which must be added interest upon the invesment in the electric apparatus; the saving shows interest at the rate of 30 per cent. upon the sum invested.—*Eng. and Min. Jour.*, March 31.

Electrical Operation of Lock Gates.—A paper read before the Royal Institute of Engineers of the Netherlands, on the new lock gates in operation at Ymuiden, in Holland, at the mouth of the Nordzee Canal. In order to decide on the selection of the motive power, a competition was arranged, the result of which was the submission of 13 designs, of which 1 was pneumatic, 8 hydraulic and 4 electric. None of these appeared to be quite satisfactory, but two electric and two hydraulic designs were purchased and applied experimentally upon smaller gates; as a result, an improved electrical design was made and has now been put into satisfactory operation. The use of electric power was rendered desirable by the distance separating the several sets of gates; an electric plant was also necessary for lighting, and the plower plants could therefore be combined. There were, however, certain disadvantages of electric power; the rapid motion of the motors had to be converted into a slow, steady movement suitable for controlling such heavy masses; the switching devices, especially in connection with automatic operation, became somewhat complicated; the dampness was also against electricity. There is one 45-hp motor for each gate, and it is required that this shall open the gate in 1.5 minutes, "against a difference of level of 10-cm," the motion being automatically arrested at each end of the travel. The power station contains two steam driven dynamos of 100-hp each, besides a large storage battery.—*Zeit. des Oest. Ing. und Arch. Ver.*; abstracted in *Eng. Mag.*, April.

Automatic Brake.—An illustrated description of a brake constructed somewhat on the principle of a Weston friction clutch and intended to obviate the unreliability due to wear. "A disc slides on a feather key on the motor shaft, and is placed between two plates, one of which is fixed to the frame of the machine, and the other swings on a link and is provided with stops to prevent rotation. This movable pressure plate is acted upon by a spring, which presses it, the disc, and the fixed plate tightly together, so that the motor shaft cannot turn. An electromagnet is provided which, when energized, pulls the pressure plate back and releases the disc." Another brake arranged to give "two pressures" is described.—Lond. *Elec. Rev.*, March 16.

Test of a Ventilating Fan.—A note referring to some recent tests of a six-foot fan driven by a 225-volt direct-current motor. The current and voltage were read with the fan on, and disconnected, the power absorbed by the fan being taken as the difference between the two. On the feed side it was enclosed by an open box; the total feed area was 76.6 square feet; the average velocity of the air was 1168 feet per minute, the speed of the fan being 300 revolutions per minute; this corresponds to 89,468 cu.ft. per minute; the net power required for the fan was 5.81-hp, corresponding to 17,543 cu.ft. moved per horse-power per minute.—Lond. *Elec. Rev.*, March 23.

Long Distance Transmission.—A note stating that long distance transmission at voltages over 10,000 is used more and more now in Continental Europe. The transmission from Vezere to Limoges, installed by the Schuckert Company, is described. In Vezere water power is used to generate three-phase current at 8000 volts for transmission partially at 8000 volts, partially at 20,000 volts. In Limoges, 47 miles distant, there is a steam plant which has to work in parallel with the water power plant in Vezere.—*Elek. Anz.*, March 1.

REFERENCE.

Improved Efficiency of Engines.—An editorial note criticising unfavorably the device of Behrend and Zimmermann, described in the Digest Jan. 6. The criticism is based upon the second law of thermodynamics, as enunciated by Sadi Carnot.—*Power,* April.

TRACTION.

Accumulator Traction in Gand.—BUSE.—A long description of the accumulator traction system in the city of Gand. Each car has two 15-hp motors at 250 volts, made by the Westinghouse Company of this country, and an accumulator battery of 108 Julien cells. The total weight of the battery is 7260 lbs., the capacity is 150 amp.-hours, if discharged at 50-amp. The consumption of fuel is 8.5 to 8.8 lbs. of coal per car mile, against 10.6 to 12.3 lbs. with the trolley system. Accumulator traction is thought to be practical in the country and in towns, where the time intervals between cars are not frequent; it should, however, not be used in important city streets where a five-minute schedule is required, as the return of the cars to the station for charging and recharging the batteries requires too much time; charging stations in the centre of a city are thought to be impossible. A great drawback is said to be the fact that the acid injures the cars; in Gand new cars were badly damaged after three months of service; efforts to prevent this were not successful.—*L'Ind. Elec.,* March 10.

Accumulator Traction in a Blizzard.—ELSHER.—An account of the behavior of the accumulator car system of Bremerhaven in a snowstorm in February, which proved very satisfactory, although there are topographical difficulties. During a day on which a heavy brizzard was raging, the service could be maintained although the snow was not removed from the rails; on some parts of the line the power consumed was five times the normal or more. Standing on the rear platform of a motor car one could see the rails behind the car fully covered with pressed snow so that the wheels did not touch the rails themselves. The trolley system with rail returns or a combined trolley and accumulator system would have failed in that case. A few days later in another snowstorm, when the snow had accumulated in many places to a depth of three feet, the service was interrupted.—*Elek. Anz.,* March 1.

Accumulator Traction in Rome.—BATTANDIER.—An article stating that the Rome Tramway Company is to replace accumulator traction by the trolley system. They have been using the Pescetto accumulator and charge the system of accumulator traction with the following inconveniences: the loss of time by recharging the batteries, the great delicacy of accumulators necessitating a very careful treatment, their weight, the odor, which seems to have troubled the passengers very much, and the high cost of the system. Reference is made to a new accumulator, devised by Garassino, which is said to have a capacity of 16 amp.-hours at a rate of 19-amp. per kilogram of plate; the formation of the accumulator requires 48 hours; it has not yet been introduced commercially.—*Cosmos,* March 3.

Automobiles.—MAXIM.—An abstract of a lecture before the Knickerbocker Athletic Club, of New York, giving a comparison of electric, gasoline and steam vehicles. The limitations of the electric automobile are its short radius of operation, amounting to about 30 miles, and the comparatively long time required to recharge the battery; it is the heaviest and most expensive; its motor is ideal; its power is stored and may be used in large or small quantities as desired; the transmitting devices are of the simplest and most easily managed kind. The gasoline automobile has the disadvantage of a reciprocating motor which is not self-starting; it gives more power from a definite quantity of fuel than either of the other types; it is especially adapted for racing. The steam automobile also has the disadvantage of a reciprocating motor; it requires a large quantity of water and quite considerable fire must be carried on it; its first cost is the lowest. The average first cost of the better makes of vehicles is given at $600 for steam, $1200 for gasoline, $1900 for electric automobiles. In the electric vehicle 90 per cent. of the skill, care and expense involved in the operation is required at the place where it is stored, 10 per cent. on the road; in the gasoline and steam vehicles 90 per cent. on the road and 10 per cent. at the place where they are stored.—*Elec. Rev.,* March 28.

Automobile Delivery Wagons.—SEVER.—A comparison of the costs of operation of horse and electric delivery wagons for city service. If the lowest average cost for horse service and the highest for electric service is taken, the cost per pound of useful load on the wagon per mile is 0.0204 cent with horse and 0.01923 cent. with electric service.—*Elec. Rev.,* March 28.

REFERENCES.

Underground Conduit and Three-Wire Trolley System.—A description of the conduit system of the London United Tramways on two miles of track. The conduit and track construction are similar to those used in New York. There are two trolley wires over each track in the trolley sections outside of the city, the two inner wires being connected to form the neutral. Three-phase current at 5000 volts and 25 periods is transmitted to substations with synchronous converters.—*Tram. R'y World,* Oct. 5; abstracted in *Science Abstracts,* February.

Automobilism in Europe.—DURAND.—An article giving lists of the principal automobile races and contests in Europe during 1900.—*Elec. Rev.,* March 28.

Electric Automobiles.—A number of brief illustrated descriptions of "electromobiles" made in this country. Also of the new repair department and charging station of the New York Company.—*Elec. Rev.,* March 28.

INSTALLATIONS, SYSTEMS AND APPLIANCES.

Laufenburg.—A note stating that the Laufenburg fall of the Rhine is to be turned to a useful purpose by putting in a turbine plant connected with electric generators. It is estimated that with 18 turbines 30,000-hp can be developed at low water.—*Eng. News,* March 29.

REFERENCES.

Dresden.—A long abstract of the official report of the municipal electric plant of Dresden, Germany, for 1898. The energy supplied was 1,560,023 kw-hours against 1,111,687 in 1897.—*Elek. Zeit.,* March 15.

Govan.—A brief description of this British plant. The three-wire system with 2 x 250 volts is used.—Lond. *Elec. Eng.,* March 16.

Glasgow.—A brief illustrated description of the electrically driven surface condensing plant for the Glasgow electric station.—Lond. *Elec.,* March 16.

Tivoli.—A description of the new Tivoli plant in course of erection, from which 8000-hp will be transmitted to Rome. There will be seven sets of turbines coupled to dynamos generating three-phase current at 10,000 volts.—*Elettricita,* 18, 48; abstracted briefly in *Elek. Anz.,* March 11.

Supply Regulations.—An article stating that in addition to the wiring rules, issued by the Manchester Corporation, a list of approved fittings is now also issued, including switches, cut-outs, distribution boxes, ceiling roses, wall plugs, lampholder plugs, lamp holders, lamp holder switches. The article gives only a general summary of the contents of the regulations.—Lond. *Elec. Rev.,* March 16.

WIRES, WIRING AND CONDUITS.

Fuses.—A. H.—An illustrated article on the calculation of fuses. The fuse should always be long enough to prevent the formation of an arc; the length depends on the size and material of the metallic contacts and should be at least 2½ to 3 inches, if pure lead or an alloy of lead and tin are used. A method is described for calculating the fusing current, if the melting point of the used metal is known and if it has the property of becoming liquid most quickly with a moderate coefficient of expansion. The formulas are developed and a table is calculated, giving the fusing current for given sizes of the fuse, both for rectangular and circular cross-sections.—*Elek. Anz.,* March 4.

REFERENCE.

Electric Underground Construction.—SPRINGER.—A paper giving information concerning the cost of laying conduits in various kinds of roads. He also describes and illustrates a method of joining feeders and gives illustrations and descriptions of work in various streets.—*Jour. West. Soc. Eng.*; noticed in Lond. *Elec. Eng.,* March 16.

ELECTRO-PHYSICS AND MAGNETISM.

Electric Arc.—CHILD.—An illustrated article giving a dissociation theory of the electric arc. The current in the arc is carried by ions and the positive ions have the greater velocity. The intense heat of the arc dissociates the gases of the arc into positive and negative ions. He shows that all known phenomena of the arc can be explained on this hypothesis.—*Phys. Rev.,* March.

Mass of the Electron.—LIEBEN.—A brief theoretical article, in which he tries to calculate the mass of an electron in another way than that based upon measurements with cathode rays. He assumes as Nernst does, that the positive and negative electrons

which correspond to the chemical elements, go from the ether into the matter at the moment of ionization, and increase the mass, so that there is an increase of weight depending on the quantity of the electrons which have entered into the material system. It is questionable whether this variation of weight is to be attributed only to the negative electrons or to both. He assumes that both have the same real weight, and calculates from weighings of Landolt that this weight is 0.077 mgr., while Kaufmann has calculated from experiments with cathode rays that the weight of one molecule negative electron is 0.530 mgr. He makes some suggestions for further experiments.—*Phys. Zeit.,* Feb. 24.

Leyden Jar.—A note stating that the Leyden jar can be used for predicting the weather. If it is placed on a scale and balanced by weights and is then charged with electricity it appears to increase in weight by an amount which may approach quite an appreciable fraction of a gramme. According to Ducla, a French physicist, this apparent change of weight depends upon the weather, and is smaller when rain is imminent.—*Elek. Anz.,* March 15.

Vibrations Produced by Vacuum Discharges.—Stark.—An account of experiments in which he sent a continuous discharge from a battery of accumulators through a vacuum tube, the exhaustion being such that the discharge was only just able to pass. A telephone introduced into the circuit then proves that the discharge is intermittent and has a more or less definite period. On placing the ear against the tube in the neighborhood of the cathode a note is heard which he terms the cathode note; its intensity may be increased by laying a strip of tinfoil loosely round the tube in the neighborhood of the cathode. The electric oscillations here produced are of the frequency of several hundred per second, and are therefore intermediate between those due to alternators and those obtained in the Hertzian wave experiments. If the electrodes consist of flexible wires or carbon filaments at right angles to the length of the tube, the cathode is put into a state of visible vibration while the anode remains stationary; this indicates an effect of the charge which resides on the walls, upon the electrodes; the effect is strongest at the cathode, where there is the greatest fall of potential.—*Ann. der Physik.,* February; abstracted in Lond. *Elec.,* March 23.

Charge Conveyed by Becquerel Rays.—P. and S. Curie.—An account of experiments made with rays from radium compounds. These rays resemble cathode rays rather than Röntgen rays, not only as they are magnetically deflected but also in the fact that they convey a negative charge, which is proved in several ways.—*Comptes Rendus,* March 5; abstracted in Lond. *Elec.,* March 23.

Magnetic Deflection of Rays.—Strutt.—A comparison of the magnetic deflections of Röntgen, Becquerel and cathode rays. His efforts to obtain some indication of a magnetic deflection of Röntgen rays failed entirely. With a field of 3270 c. g. s. units no perceptible deflection is obtained, and in view of the probable limit of sensitiveness of apparatus he says that to produce a curvature of radius 1 cm. in Röntgen rays a magnetic field would be required of at least 60 million units. To produce the same curvature in cathode rays, a field of 315 units is required; in Becquerel rays a field of 5000 units.—*Proc. R. Soc.,* March 3; abstracted in Lond. *Elec.,* March 23.

Magneto-Optic Reciprocity.—Corbino.—An account of experiments in which he proved the incorrectness of Sheldon's announcement of the creation of a varying magnetic field by the rotation of the plane of polarization of a mechanically rotated beam. As such an effect should vary directly with the speed of rotation, he produced a plane polarized beam with rotative plane by interference of two circularly polarized beams, reversed with respect to each other, and of slightly different periodicities, and increased the speed of rotation from 300 to 2,000,000 per second. This beam was sent through a magnetizing coil filled with carbon bisulphide. Although the effect in this case should have been 6000 times the magnitude of Sheldon's effect, no magnetic effect of any kind was observed.—*Nuovo Cimento,* December; abstracted in Lond. *Elec.,* March 23.

Effect of Magnetization on the Electricity of Rods.—Stevens.—An illustrated account of experiments made to determine the effect of magnetization upon torsional electricity. Magnetization of an iron or steel rod increases the torsional elasticity; the effect is greater in iron than in steel rods of the same dimensions; the increase in elasticity varies with the length of the rod. These results are in distinct agreement with those of his experiments on elasticity of flexion, noticed in the Digest Sept. 2.—*Phys. Rev.,* March.

The Change in Length of Soft Iron in an Alternating Magnetic Field.—Austin.—An account of experiments, illustrated by diagrams. The general course of the change in length of soft iron in an alternating magnetic field is the same as in the direct field. For all values of the strength of the field above 25, and at least as high as 375, the length of the soft iron specimen is less with an alternating than with a direct field. The maximum elongation gradually becomes less as the frequency of the alternations is increased; it appears as though there were an appreciable viscosity in the molecular movements depending on the rapidity of the alternations.—*Phys. Rev.,* March.

REFERENCES.

Electric Deformation of Dielectrics.—Sacerdote.—A brief abstract of a French Physical Society paper on this theory, a preliminary account of which was noticed in the Digest Oct. 7.—*L'Ind. Elec.,* March 10.

Röntgen Rays.—Trowbridge.—A long illustrated popular article giving a summary of the present knowledge of Röntgen rays.—*Appleton's Pop. Sc. Mo.,* April.

Electro-Chemistry and Batteries.

Storage Battery Problems.—Wade.—The first part of a paper read before the British Institution of Electrical Engineers. He calls attention to the fact that in spite of the theoretical reversibility of every galvanic combination, yet only one is commercially practical; the lead, sulphuric acid, lead peroxide cell; the really unique characteristic of this combination lies in the fact that the electrodes, the active materials, and the compounds produced from them are, under every normal condition of use, all insoluble in the electrolyte used. In all other known cells this is not the case; if a soluble negative is used, as zinc, it can only be redeposited effectively under certain conditions and for a limited number of times; if the positive is soluble, the soluble salt inevitably reaches to the negative electrode sooner or later, where it is also deposited, setting up destructive local action; the same objection applies to all kinds of fluid depolarizing agents. The problem of devising a new storage battery is to find a new combination with insoluble electrodes; he thinks that, considering the extent to which the field has already been worked over, success, if ever attained, will probably depend on the utilization of some of the less studied and more obscure reactions into which the metals enter. The processes taking place in the lead accumulator are assumed by him to be the following: Before the commencement of discharge the active materials of the fully charged negative and positive electrodes consist of lead and lead peroxide respectively, "but both in allotropic or polymeric states, and possessed of a molecular structure far more complex than is represented by the formulæ" usually used. On discharge no molecules of lead or lead peroxide are wholly or directly converted into normal lead sulphate; but, still maintaining their complex molecular structure, they pass through a long series of true compounds containing the sulphuric acid radical in gradually increasing proportions; in this way no portion of the active materials loses its conductivity nor is cut off from electrical connection with the remainder, and its easy and rapid desulphation on recharge is therefore provided for. This absorption of the sulphuric acid radical "does not and cannot go on until the molecules are fully sulphated, because at some intermediate stage their electrical resistance, which previously has only been increasing slowly, commences to go up with extreme rapidity;" this change is necessarily accompanied by an equally sudden and rapid fall in the cell's potential difference which soon passes below the usual limiting value. If the current is kept flowing through the cell by means of an external e. m. f., reversal (when "forming" electrically) commences; no further "sulphation" of the active materials takes place, the proportion of the sulphuric acid radical present in the molecules, remaining constant throughout this intermediate stage, but lead gradually passes over to peroxide at the negative, and vice versa at the positive, until their composition is exactly reversed; here again the change is only effected through a whole series of intermediate compounds, and the molecules retain their complex structure intact. The recharge of a cell, whether as the continuation of the reversal or as the normal charge following on a discharge, consists essentially in the gradual withdrawal of the sulphuric acid radical from the molecules, until allotropic lead and lead peroxide are again reproduced; the other reactions during the charge are only incidental so far as the active materials are concerned. Sulphating consists in the breaking up of the complex molecules, containing more or less sulphuric acid, into a number of simpler and independent molecules of normal lead sulphate and of lead or lead peroxide; this arrangement of structure destroys the continuity and conductivity of the active material;

nothing further is needed to bring about this change than rest on open circuit, but the instability of the compounds increases with the extent to which the cell is discharged and with the strength of acid used in it. He then shows that to obtain the maximum output from any active material the electrolyte must have access to each of its individual molecules, so as to include them all in the electrolytic circuit, and its porosity therefore must be thoroughly molecule. He thinks it yet remains to be recognized how far reaching the consequences are of lack of diffusion of acid from the main body of the electrolyte into the depleted solution in the pores of its active materials, and how many of the faults and shortcomings of the cells may be attributed to it. The higher the rate of discharge or the more impeded the diffusion, the less is the interior of the active material drawn upon for the maintenance of the current; while if either of these conditions is pushed to an extreme, nearly the whole of the work is done by a very thin outside layer, and by the time this is exhausted hardly any acid will be left in the electrolyte surrounding the remainder; certain similar conclusions may be drawn as to recharging. He then shows that not only the output of a cell, but its durability and life are affected through insufficient diffusion and that also the electric efficiency is reduced. The molecular porosity of active materials of the Planté type, and of all those of the Faure type prepared from litharge or minium, is probably only about 25 per cent., and can hardly exceed 40 per cent., even assuming that a very heavy preliminary sulphation takes place. A more porous material is obtained by the electrolytic reduction of lead chloride which has had a small proportion of zinc chloride fused with it; the two form a molecular compound that sets to a crystalline mass of low specific gravity; and when the zinc chloride and the chlorine of the lead chloride have been removed, every molecule of the lead remaining is surrounded by a space of about twice its own size; it has therefore a true molecular porosity of 65 to 70 per cent. and is capable of holding about two-thirds of its own apparent volume or twice its actual volume of electrolyte. This is, however, only one step in the right direction. In the ideal active material every one of its molecules should be surrounded by a space containing sufficient electrolyte for its complete discharge, so that no diffusion has to take place either from the outside or between different parts of the active material itself. The problem is to prepare an active material possessed of an extremely high molecular porosity, without reducing too much its cohesion and mechanical strength generally; there are no fundamental difficulties in the way. In an editorial in the Lond. *Elec.* the immense importance of the storage battery is shown, and some reflections are given upon the effects which the advent of an improved storage battery might be expected to produce in electrical engineering practice.—Lond. *Elec., Elec. Eng.,* March 23.

Lead Accumulators.—HEINEMANN.—An article on the use of organic salts in the preparation of the active material for pasted plates. Some organic compounds, such, for instance, as glycerine and butyric and lactic acids, have the property of forming quickly drying compounds with lead oxides. The organic paste has the advantage that it can be greatly compressed, which also improves its durability, for the loss of active material caused by the wash of the electrolyte between the plates is thereby diminished. According to the material used, various products are formed in the production of the lead oxide paste, among others some of a resinous nature, which are not unlike caoutchouc in their stability, and undergo no further change; these serve to unite the highly compressed lead oxide particles, and offer very little resistance to the passage of the current, on account of the extreme thinness of the film which separates and retains the particles. Glycerine has many advantages, but on oxidation it yields no resinous body and disappears entirely from the plate during the process of formation. For the formation of that caoutchouc-like body by electrolysis, the oils of the cypress, birch and pine species have been suggested by him in a German patent. Accumulators made according to this patent have proved satisfactory in practice; after five months' continuous daily use for traction purposes by the Berlin post office, the electrodes of such a battery were in perfect order, while the positive plates of a Fulmen cell were worn out after a hundred charges. He gives in a table a comparison as to size, weight and capacity of accumulators of the German Accumulator Co.; the Fulmen cell and his cell.—*Centralbl. fuer Accum.,* March 1; abstracted at some length in Lond. *Elec.,* March 23.

Accumulator Charge Indicator.—BELLATI.—An illustrated description of a device, showing the amount of charge which has been put into or withdrawn from an accumulator, so that its condition at any period of its working can be seen at a glance. The apparatus shows the change of density in the electrolyte and is based on the principle that in the case of two vessels communicating with each other, the height of the fluid in each above the dividing layer is in the inverse proportion to their density. The following form of the apparatus is illustrated: A horizontal glass cylinder placed in the electrolyte has an opening on its lower side, by which it is partially filled with the electrolyte. On its upper side it is prolonged into a thin tube, which at first rises vertically up to the level of the electrolyte and then inclines towards the horizontal; it is filled with petroleum, which is lighter than the electrolyte and does not mix with it. The bent part is divided into millimeters, on which the position of the upper end of the petroleum column is read off.—*Centralbl. fuer Accum.,* Feb. 1; abstracted at some length, with illustration, in Lond. *Elec.,* March 23.

Calcium Carbide.—NEUBERG.—A comparison of the relative merits of acetylene obtained from calcium carbide, as compared with electricity, for lighting, heating and power purposes. The cost of electricity is based upon the price charged by the Berlin Electric Works, which is 13¾ cents per kw-hour for lighting and 4 cents for cooking, heating and motor driving; 1000-kg calories cost 15.9 cents for lighting and 4.6 cents for cooking, etc. The carbide is supposed to cost 4 cents per pound. He finds that 1000-kg calories, generated by the combustion of acetylene, cost 4.2 cents. Besides these, the efficiency of the apparatus and machines is to be considered, such as lamps, cooking apparatus and motors. One Hefner candle-hour from electric incandescent light costs 0.038 cent, from an acetylene lamp 0.030 cent, the life and the price of both lamps being equal. The cost of heating 1350 gram water from 30° to 92° C. by electricity is 0.47 cent, by acetylene 0.69 cent; the cooking by electricity is to be preferred in every respect to cooking with acetylene. For an electric motor one hp-hour costs 3.64 cents, for an acetylene motor 8.78 cents; besides this, the amortization, the consumption of oil and cooling water, the attendance and the efficiency as a function of the load are to be considered; all these four points increase the price of the hp-hour for the acetylene motor far more than for the electric motor. He concludes that acetylene lighting is cheaper than incandescent lighting, but that acetylene cannot compete with electricity for heating and power purposes.—*Elek. Zeit.,* March 1.

Calcium Carbide.—MASUJIMA.—An article of a general character on the use and manufacture of calcium carbide. In the Japanese market it costs $179.20 per ton, which is very high when compared with other countries; the high price is probably due to the importers having a monopoly; he believes the cost will soon be reduced. He gives the following table showing the percentage composition of the gases generated from three different samples made in the three different countries which now supply that market:

Made in	Phosphorated Hydrogen.	Sulphur Hydrogen.	Ammonia.	Hydrogen.	Nitrogen.	Oxygen.	Acetylene.	Total.
U. S.....	0.05	0.08	0.08	0.09	0.42	0.87	98.41	100.00
Germany...	0.03	0.07	0.07	0.07	0.20	0.55	99.01	100 00
Switzerland	0.03	0.10	0.11	0.16	0.34	0.63	98.63	100.00

Three hundred and ten litres of acetylene gas is said to be obtained from 1-kg of calcium carbide prepared by the writer in Japan, but he does not give any particulars concerning the method which he used. He considers the gas safe. He recommends the use of efficient generators, and states that the accumulation of heat not only decomposes some of the acetylene but also forms benzine and other similar compounds which reduce the amount of effective acetylene. He calls the attention of gas engineers to the advantage of mixing acetylene with the ordinary coal gas as an illuminant. He concludes that if the cost of calcium carbide is slightly less it will be the best and cheapest method of illumination in Japan.—*Elec. Friend* (Japan), Jan. 15.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Standards of Light.—PETAVEL.—A continuation of his illustrated paper (Digest, March 31). He discusses, with the aid of an illustration, the Lummer and Kurlbaum incandescent platinum standard proposed in 1894, and described in the Digest at that time; it does not possess all the qualities required of a primary standard, but may be of the greatest value as a standard of reference for certain pur-

poses, as for checking the values of the Hefner lamps, for which purpose it is used in the German Reichsanstalt. In this standard a strip of platinum foil 25-mm wide and 0.015-mm thick is brought to incandescence by a current of about 80 amperes and the temperature is increased until one-tenth of the total radiation is transmitted through a water trough 2-cm in width, the ratio being determined by means of a bolometer. The adjustment of the temperature with the required degree of precision is most tedious and almost impossible under the most favorable conditions. He also gives a summary of preliminary research on Violle's molten platinum standard of light.—Lond. *Elec.*, March 16.

Continuous and Interrupted Magnetization.—GUMLICH and SCHMIDT.—An account of an investigation made in the German Reichsanstalt; the results are given in some tables and a diagram, and are summed up as follows: The magnetic conditions of soft material are influenced by step-by-step variation of the field strength in the same direction as by external concussions; while the maximum induction is hardly changed at higher strengths of field, the remanent magnetism, the coercitive force and the energy loss decrease with increasing steps. The differences from the values obtained by continuous magnetization cannot be neglected in exact measurements with soft materials, while for hard materials they are not much above the errors of observation.—*Elek. Zeit.*, March 22.

Measuring Short Electric Waves.—PIERCE.—An illustrated paper on the application of the radio-micrometer to the measurement of short electric waves. For a receiving instrument he uses a resonating thermal junction like that used in the experiments of Klemencic and Cole; but instead of a separate galvanometer, he makes the thermal system a part of the suspension in an apparatus similar in other respects to the radio-micrometer of Boys. He gives an account of experiments which show the adaptability of the apparatus to quantitative work with electric waves.—*Am. Jour. of Sc.*, April.

Wehnelt Interrupter.—TURPAIN.—An abstract of a French Academy note comparing the Foucault interrupter with the Wehnelt and Caldwell interrupters. Regarding life and economy the Caldwell interrupter is to be preferred to the Wehnelt; both are preferable to the Foucault in convenience and frequency; regarding regularity and power, the Foucault break is just as good as the Wehnelt interrupter for the limits of frequency within which it acts; it also allows for adjusting the number of interruptions per second.—*L'Eclairage Elec.*, Feb. 24; *L'Ind. Elec.*, March 10; *L'Elec.*, March 10.

Silver Voltameters.—MERRILL.—An account of an investigation of the influence of temperature, pressure, used solutions and size of anodes on the deposit in silver voltameters. No pressure effect could be found. An increase of temperature probably does not of itself increase or diminish the deposit, but the deposits from cold solutions differ in physical appearance. Two series of tests were made on the relative deposits from fresh and used solutions; the deposit from the old solutions is greater than that from the fresh, but the latter was more coarsely crystalline and slightly less white in color than the former; the increase in deposit from used solutions must be due to "some reduction of the valence of the silver in the electrolyte." The relative size of the anodes within reasonable limits has no appreciable influence.—*Phys. Rev.*, March.

REFERENCES.

Measuring Instruments for Three-Phase Currents.—ARNO.—An illustrated French translation in full of his Como Congress paper, abstracts of which were noticed in the Digest Nov. 4.—*L'Ind. Elec.*, March 10.

Mirror Voltmeter With Large Scale.—THIERMANN.—A long illustrated description of a mirror galvanometer with telescope reading, a sliding rheostat with 11 resistances and a standard cell for use in the Technical High School of Hanover for measuring pressures between 750 and 0.0007 volts.—*Elek. Zeit.*, March 15.

Measuring Instruments in High Tension Plants.—SCHUELER.—A reply to the criticism of Widmann (Digest, March 31).—*Elek. Zeit.*, March 15.

Electric Meters.—KOHLRAUSCH.—A communication replying to some remarks in the paper of Uppenborn noticed in the Digest March 17.—*Elek. Zeit.*, March 8.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Telephone Call Counter.—HEFNER-ALTENECK.—A paper read before the Electrotechnical Society of Berlin, describing a counter devised by him. A small case containing the mechanism is placed on the telephone. To call up anybody one must first move a lever on this case; this moves the pointer on the counter dial one division, and connection with the station is made; after a certain time interruption occurs automatically; this is accomplished by a small clockwork which is wound up by the motion of the lever on the counter and which breaks the connection of the inductor after a certain time, shortly before it stops. It may be modified to count the calls for both the calling and the called parties, or to count the duration of the calls. He thinks that the best method is to count the duration of the calls for both the calling and the called parties, because this can be done in the simplest way, and because it involves a smaller charge for calls. —The paper was followed by a long discussion. Feyerabend gave a summary of all the 122 designs of call counters which have been offered to the German Governmental Telephone Office. The German governmental office requires that a counter should count the number of calls, but only those that were followed by the desired connection; that it acts entirely automatically; that it is placed at the station; that it acts as purely mechanically as possible; that it is simple and sure; that it accommodates itself to the apparatus and the methods in use; and that it is cheap. He thinks that it is nearly impossible to construct a counter which fulfils all these requirements. West referred to the fact that in Switzerland the introduction of the method of counting the calls has greatly diminished the number of calls, and that by such a method the same receipts are never obtained as on a rental system; the purpose should be to make the telephone service cheaper, which can be done by party lines (his system was described in the Digest Feb. 24).—*Elek. Zeit.*, March 1.

Tramway Currents and Submarine Telegraphs.—JAMIESON.—An abstract of the discussion which followed his paper (Digest, March 17, 31). Also an illustrated communication by him, describing experiments which he claims prove conclusively that electromagnetic induction does take place in an insulated conductor wholly surrounded by another, when varying currents are passing into the latter. For instance, if varying currents are passed through the lead tube sheathing of an ordinary electric light leading wire, which is joined in circuit with a telephone and a galvanometer, then these instruments at once respond to the fluctuations of the current in the sheathing. He adds some theoretical remarks on this phenomenon. There is also an editorial note on the subject.—Lond. *Elec.*, March 23.

REFERENCES.

Telephone Transmitter.—CLEMENT.—An illustrated article describing several forms of transmitters, especially the Stromberg, in which the variation in resistance is principally due to a variation in area between the two electrodes, for which reason it is thought not to be within the scope of the Berliner Patent.—*Tel. Mag.*, March.

Coherer.—VAN DER NAILLEN.—An illustrated description of some experiments of Branly with coherers.—*Jour. of Elec.*, February.

Electric Signals.—THOMPSON.—A paper read before the Lake Superior Mining Institute, describing the electric signals used at the West Vulcan iron mine.—*Eng. and Min. Jour.*, March 31.

Railway Signals.—KOHLFUERST.—A long illustrated German article on Virgillito's block signal system (Digest, March 10).—*Elek. Zeit.*, March 8.

MISCELLANEOUS.

Dangers of Alternating Currents.—HELLMUND.—A short illustrated article showing that it is dangerous to touch the inner conductor of a concentric alternating-current cable, laid in the earth, as the outer conductor forms a condenser with the lead casing, and a person in contact with the earth and touching the inner conductor closes this condenser circuit. If the resistance of the human body is 30,000 ohms, the voltage 6000, the frequency 50, and the capacity of the outer conductor to the lead casing 1 microfarad, the current through the human body is 0.2 ampere, which is far over the danger limit. If one conductor of an alternating current circuit is laid in the earth, thus forming a conductor to it, and the second conductor is parallel to a third conductor, which has no connection with the circuit, but forms a conductor with the second conductor, a person in contact with the earth, closes a circuit, when touching the third, apparently inactive conductor.—*Elek. Anz.*, March 1.

Atmospheric Electrification and Human Pathology.—Some editorial notes criticising the opinion expressed by Perry and Schlieb that there is a close connection between atmospheric electrification and human pathology. They observed, for instance, that neurotic patients are depressed when the air is negatively electrified and abnormally stimulated when the electrification is positive. It is thought that these effects may have been produced by the physical causes

which led to the electrical conditions, instead of by the electrification itself. A conclusive experiment would be to see whether the same change of symptoms is produced by artificial electrification of the air in a patient's room, under constant barometric and hygrometric conditions.—Lond. *Elec.*, March 23.

REFERENCES.

Ignition Tube.—Baudry de Saunier.—A description of an ignition or sparking plug (for gas engines), the main point in which is the form of housing given to the porcelain plug and insulation, which permits the use of a two-part porcelain, through which one conducting wire passes; the object is to keep down the temperature of the outer projecting porcelain and to reduce breakage.—*Automotor Jour.*, 4, p. 99; abstracted in *Science Abstracts*, February.

Copper.—Hatch.—The conclusion of his long statistical article noticed in the Digest March 24. He deals with the production of Chile, Germany, Australasia and the minor contributing districts. Unless new and abundant sources for copper are opened up in the early part of the next century, or some substitute is found for it in the electrical industry, there is no prospect of copper being overproduced.—*Eng. Mag.*, April.

Bohemia.—Kopecky.—A short communication on the conditions of the electrical industry in Bohemia.—*Elek. Zeit.*, March 1.

Berlin.—An article on the present very favorable conditions of the greatly developed electrical industry of Berlin, the capital invested being $75,000,000. The whole capital invested in the electrical industry of Germany is said to be over $175,000,000.—*Elek. Anz.*, March 4, 11.

New Books.

Indicator Diagrams. A Treatise on the Use of the Indicator and its Application to the Steam Engine. By W. W. F. Pullen. Manchester, England: The Scientific Publishing Company. 238 pages, 261 illustrations. Price, 6 shillings.

This exhaustive work upon indicator practice contains in addition to much original matter a compilation of about all the valuable data concerning indicator practice which has appeared in technical journals during the past few years. The author has used freely the proceedings of the leading engineering societies of America and Europe. The work is divided into fifteen chapters and an appendix, the latter consisting of the standard tables necessary to the indicator user.

The first chapter is devoted to the measurement of power with the indicator. Then comes a chapter describing indicator rigs and reducing gears and another describing the standard makes of indicators. This is followed by a chapter on calibrating indicator springs and another on errors in the indicator diagram. Then follows chapters on the preliminary analysis of the diagram, and diagrams showing variation of load. The two following chapters are devoted to admission and steam lines, and to exhaust and compression lines respectively. Then follow valve chest and steam pipe diagrams, and adjustment of the slide valve, after which is a chapter on pump diagrams, and another on miscellaneous diagrams.

The closing chapters are devoted to averaging diagrams and mechanical efficiency, and to slide rules and calculations respectively, the book closing with an appendix of tables.

National Electric Light Association. Report of the Twenty-second Annual Convention, held at New York, May, 1899. Published by Order of the Executive Committee. New York: The James Kempster Printing Company. 330 pages, 34 illustrations.

The report of the Twenty-second Convention of the National Electric Light Association forms a volume of 330 pages, containing the following papers, together with the discussions upon them:

A Local Transmission System—Development and Operation, by W. S. Barstow; Rotary Transformers and Storage Batteries as Related to Long Distance Transmission, by William Lispenard Robb; Transformer Tests, by W. E. Goldsborough; Single-phase Distribution, by Herbert A. Wagner; Underground Electrical Construction, by Louis A. Ferguson; Notes on Underground Distribution of Two-phase Currents in New York City, by E. A. Leslie; Means of Attaining Safety in Electrical Distribution, by W. L. R. Emmet; Transformers—Iron Loss—Its Increase—The Remedy, by G. Wilbur Hubley; Alternating Current Generation and Distribution, by H. M. Atkinson.

There are also published the following reports: Committee on Standard Candle Power of Incandescent Lamps, by Dr. Louis Bell, chairman; Committee on Legislation Regarding Theft of Electric Current, by E. A. Armstrong, chairman; Committee on Standard Specifications of Electrical Apparatus, by Paul Spencer; Committee on Amendments to Freight Classification, by Jas. I. Ayer.

These reports and papers have been published either in full or in abstract in these columns, and are perhaps in part at least familiar to the reader. The book, however, includes in full the discussions, which in some instances are of notable value; it is needless to say that the diagrams and illustrations incident to papers and discussions are reproduced.

The events of the Convention are assembled in the book in chronological order and are supplemented with tables and statistics concerning the Association and its committees, business transactions, reports of sub-treasurer, and similar matters incident to the operation of such an organization. The frontispiece is a half-tone reproduction of a photograph of the president, Mr. A. M. Young. The work is typographically attractive and neatly bound, and is a most convenient compendium of all of the technical interest that the Convention developed.

Signaling Across Space Without Wires. Being a Description of the Work of Hertz and His Successors. By Prof. Oliver J. Lodge, F.R.S. Third Edition. London: The Electrician Printing & Publishing Company. 133 pages, 67 illustrations. Price, $2.00.

The second edition of Prof. Lodge's admirable book appears in an enlarged form, and now contains his lecture on the work of Hertz, sections on the application of Hertz waves and coherer signaling to telegraphy, and on details of other telegraphic improvements along similar lines; a history of the coherer principle, communications by Elihu Thomson and Dr. Morton on bad contact phenomena, and an account of the photoelectric researches of Profs. Elster, Geitel and Righi.

The Royal Institute lecture contains an excellent exposition of the methods of generating and detecting electric waves. As evincing the amount of work which has been spent on the latter question, over thirty different forms are described, and to these the writer might add the following: 1. Continuous band of silver wire passing through chlorine gas or sulphuretted hydrogen, and then over metal pulley. 2. Slightly greased, or otherwise coated, plate and syphon-recorder ink-tube resting on plate. 3. Explosion of unstable substance or a mixture of gas and air. 4. Rotating wheel with stylus resting on it, coefficient of friction changed by spark cutting through film, but not by electrolysis. 5. Moving plate with thin film of silver chloride with silver stylus resting on it, and developing photographically. A full account is given of Lodge's method of "tuned" receivers and senders, and of the methods and results obtained by other workers in the field, more especially, of course, Marconi.

The chapter on the history of the development of the coherer is very interesting reading. The book is, naturally—its author being an authority on the subject and a pioneer in the work—practically free from errors, the only exception noted being on page five, in describing the method of generating waves, which should be modified somewhat, as the only time when waves are generated by oscillations in a charged conductor is when the energy is *not* alternately electrostatic and magnetic at each half swing. So long as this *is* the case, there is no radiation of energy.

BOOKS RECEIVED.

Hydraulic Power Engineering. A Practical Manual on the Concentration and Transmission of Power by Hydraulic Machinery. By G. Croydon Marks. New York: D. Van Nostrand Company. 300 pages, 201 illustrations. Price, $3.50.

Dynamometers and the Measurement of Power. A Treatise on the Construction and Application of Dynamometers. By John J. Flather. New York: John Wiley & Sons. 394 pages, 115 illustrations. Price, $3.00.

The Electric Automobile. Its Construction, Care and Operation. By C. E. Woods, E.E., M.E. Chicago and New York: Herbert S. Stone & Co. 177 pages, 22 illustrations. Price, $1.25.

Pratique Industrielle Des Courants Alternatifs. Par G. Chevrier, ingenieur a l'Usine Centrale du Secteur Electrique de la Rive Gauche de Paris. Paris: Georges Carre et C. Naud. 256 pages, 109 illustrations.

Flame, Electricity and the Camera. Man's Progress from the First Kindling of Fire to the Wireless Telegraph and the Photography of Color. By George Iles. New York: Doubleday & McClure Co. 398 pages, 115 illustrations. Price, $2.00.

Directory of Electrical Societies, Etc.

Northwestern Electrical Association. Next meeting, Waupaca, Wis., June 26, 27 and 28, 1900.

Chicago Electrical Association. Next meeting, April 20. Paper by C. A. Brown.

Canadian Electrical Association. Next meeting, Ottawa, Ont., June 27, 28 and 29, 1900.

American Street Railway Association. Next meeting, Kansas City, Mo., Oct. 16, 17, 18 and 19, 1900.

National Electric Light Association. Next meeting, Chicago, May 22, 23 and 24, 1900.

National Association of Municipal Electricians. Next meeting, Pittsburg, Pa., Sept. 25, 26 and 27, 1900.

American Electro-Therapeutic Association. Next meeting, New York, Sept. 25, 26 and 27, 1900.

Association of Railway Telegraph Superintendents. Next meeting, Detroit, Mich., June 20, 1900.

Southwestern Gas, Electric & Street Railway Association. Next meeting, Waco, Texas, April 12, 13 and 14, 1900.

Brooklyn Institute of Arts and Sciences. Next meeting, 2:30 p. m., April 14, Museum Building, Eastern Parkway, Brooklyn. Paper, "Electrostatic Machines," by Prof. John S. McKay.

American Institute of Electrical Engineers. Next meeting, April 18.

Preservation of Electric Line Poles, Cross Bars and Railway Ties.

Of the various methods of impregnation of wood with preservative materials, one developed and patented by Mr. Fritz Hasselmann, and now quite extensively used in Germany, is being introduced to this country by the Barschall Impregnating Company, of New York City. This process is covered by United States patents Nos. 580,488, dated April 13, 1897, and 626,538, dated June 6, 1899. The company has established works in Perth Amboy, N. J., where apparatus for impregnating railway ties, electric line poles, cross arms, and other wooden forms exposed to the weather, has been built with a capacity of 15,000 cubic feet daily. The treatment differs somewhat from those previously known in this country, the advantages claimed for it being given in the following description.

The treatment consists of boiling the timbers in closed chambers under a pressure varying from 15 to 45 lbs. per square inch. The impregnating liquid consists of a solution in varying proportions (depending on the quality, grain, age, etc., of the lumber to be treated) of the sulphates of copper, iron and aluminum, and kainit, a natural salt, mined at Stassfurt, Germany, containing chloride of magnetism and sulphate of potassium and magnesium. By this process the sap is dissolved by the kainit and carried off in the liquid, green wood being therefore as easy to treat as dry. The copper destroys any germs of decay that may be present, while the iron combines chemically with the cellulose or the fibre of the wood to form a chemical compound which is insoluble in water. By this means, those well-known preservatives—the salts of iron and copper—are made to thoroughly penetrate the lumber and then remain in a form such that they cannot be soaked out by water.

The advantages claimed for this treatment are that the impregnation is complete throughout the whole mass of the timber and is not limited to a slight depth below the surface. The chemical combination of the materials with the fibres of the wood renders them insoluble, so that they are not dissolved by long continued exposure. It is claimed that wood thus treated retains all of its desirable properties, such as elasticity, tensile strength, etc., and that it becomes considerably harder without any perceptible increase of weight, and is thus able to withstand greater crushing strains. In this way pine and other soft woods can be used where oak is otherwise necessary. It also becomes less inflammable, a great advantage over the creosoting process.

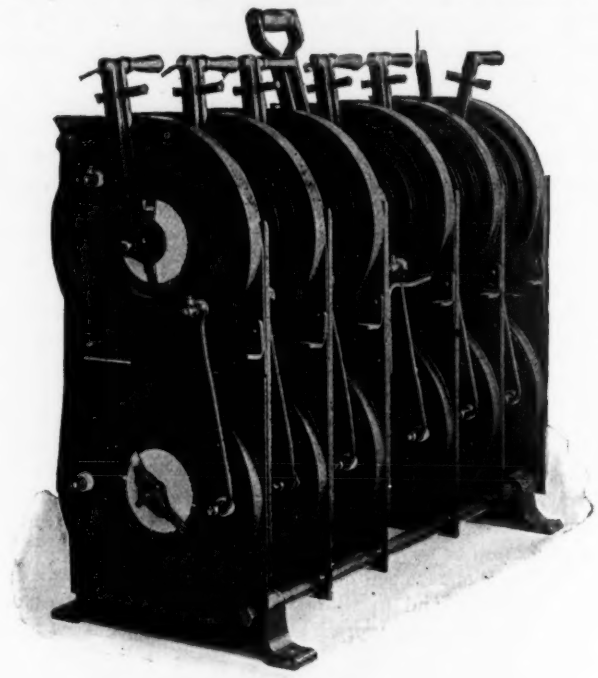
Tests recently made in January by Government officials are claimed to show a remarkable reduction of the decay which attacks poles at the point where they leave the ground. These tests were made under unusually severe conditions giving pronounced decay or untreated vale timber, but no indication of decay on soft woods treated by the Hasselmann process.

The Barschall Impregnating Company has introduced its process among the steam railroads, which apply it to ties in treating tanks already built for the application of older processes. The company also treats lumber in its Perth Amboy works for use in adjacent territory. Later additional works will be established in various sections of the country so that material can be handled for any consumer without excessive cost of transportation. A wide field for the process which is now being entered is the treatment of electric railway ties, and electric light, railway, telephone and telegraph poles and cross arms.

A New Type of Theatre Dimmers.

The accompanying cut illustrates a new type of theatre dimmer recently placed on the market by the Wirt Electric Company, 1027 Filbert Street, Philadelphia. The dimmer is of the interlocking type and suitable for either two or three-wire circuits. As will be seen, the plates are all double, the two parts being joined by connectors when used on a two-wire circuit, these connectors being removed for a three-wire circuit. If so desired, the plates may be placed in a series to adapt the dimmer for taking care of about one-quarter of its maximum load. The switches are of the laminated brush pattern, securing an excellent contact with the minimum pressure. This enables a large number of dimmers to be operated with ease and prevents undue wear of the commutator and switch.

Among the more important features claimed by the makers of the



THEATRE DIMMER.

Wirst dimmer is that no enamel is used in its manufacture, as enamels are likely to crack upon the application of a sudden load or heavy overload. No filler, such as sand or cement, is employed, the hygroscopic property of which leads to the absorption of moisture which either rusts out the dimmers or permits electrolytic action to destroy it. Mica insulation is used throughout and there is an absence of small parts such as nuts, pins, washers and short connecting wires at the contact points to eventually loosen and break down the rheostat.

Being completely encased in iron, ample protection is afforded against injury, while a miximum of active radiating surface is offered. The commutator and switch are also thoroughly protected against injury.

The resistance material is a continuous ribbon wound flat against the radiating plate, from which it is separated by a thin sheet of mica. There is no break or joint into the desired number of steps, never less than fifty, which steps make direct contact with the con-

tact bars, no connecting wires, or twisted or soldered joints being used. The resistance is tapered according to the ampere capacity desired at each point, and the steps graded in proportion to the heat radiating capacity required. This also provides a large switch contact where the current is large, and a small contact where the current is small. This construction permits the heat to be most readily conducted to the external surface and thence dissipated; consequently, the resistance material always runs comparatively cool, a condition which best fortifies it against injury in case of an accidental overload.

By the above method of distributing the heat by means of tapering the resistance and grading the steps, each plate is worked at its greatest efficiency and a rheostat therefore enabled to carry a heavier load for the size of the plate than is possible under any other condition. The large number of steps in the dimmer and the careful tapering of these, insures that the light shall be dimmed without perceptible jumps. The grading of the commutator bars is a particular advantage for dimmers. The commutator consists of a series of regulating bars, progressively varying in size in proportion to the current variation. This affords a large contact surface for the heavy current, and a small contact surface for the light current. This combined with a composition leaf brush insures an easy running switch with good wearing qualities.

Maintenance of Electrical and Steam Plants.

It is becoming a well recognized principle for owners of expensive properties to insure these against sudden and unexpected losses, generally of a magnitude too great for them to meet, the risk of such losses being taken by comparatively wealthy organizations, known as the insurance companies, who depend upon a system of averages for their compensation. Another condition of proprietorship on which insurance is desirable is the ownership of machinery or apparatus which the owner does not understand and in the care and maintenance of which he is, therefore, more or less helpless. He can, to be sure, engage employees who are presumably competent to attend to the apparatus, but owing to his own lack of knowledge upon the subject this presumption may be and often is a mistaken one. The employee is, at the best, not entirely responsible for the apparatus under his care and may shift the responsibility, should trouble come through his incompetency. In case repairs or reneweals are needed, the owner is more or less at the mercy of those who must undertake the work, owing to his lack of exact knowledge as to what is needed. On this account the existence of a company which would step in and assure the maintenance of his machinery in proper running condition for a given sum, would prove to many an owner of such machinery a great boon. Such a company is The Maintenance Company, of 220 Broadway, New York City.

This company enters into a contract with its patrons, guaranteeing them for one year against any losses on account of failure of or accident to their electrical, gas, steam and other machinery, exclusive of wiring. Differing from other companies which have engaged in similar lines of business in the past, The Maintenance Company does not operate a repair shop, but renews, at its own expense, all parts when required with duplicates from the original manufacturer; patch work is thus avoided, the machine is maintained in practically as good shape as new, patent rights on details of construction are not infringed, and the good-will of the manufacturers is retained as they lose no business, in addition to which they feel no risk of their machines being repaired by unskilled men.

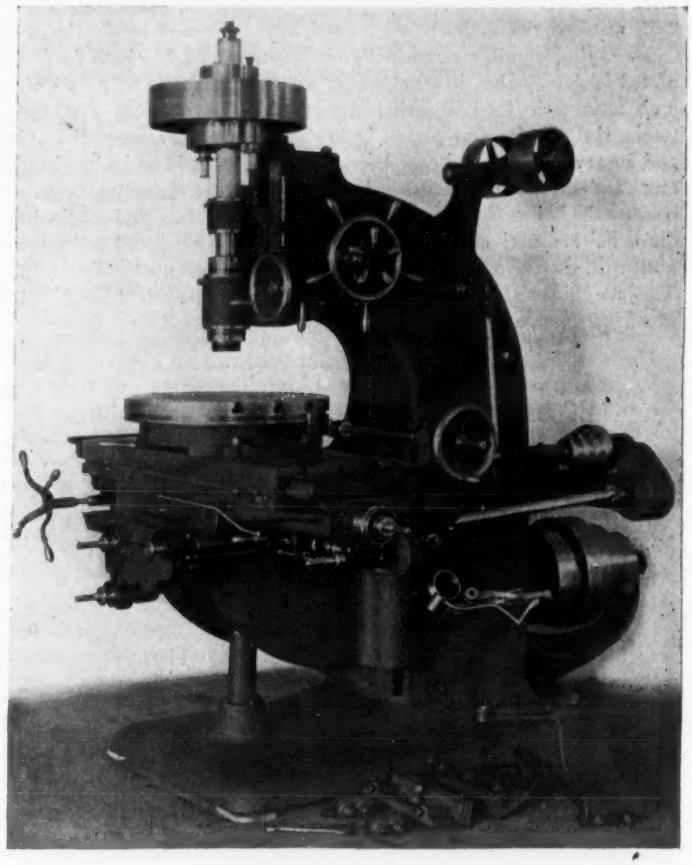
Naturally The Maintenance Company, after issuing such a guarantee, takes care that the apparatus is kept and attended in such a way as to avoid failures and break downs, the expense of which the company must assume. The company therefore has a corps of expert inspectors who have at their disposal the best of instruments for the making of tests and who are directed to regularly inspect the machinery and see that it is in the care of competent men. The inspectors also act as instructors to the engineers and help them in case of trouble which they do not understand.

The company was organized with a capital of $100,000, which is fully paid in, part of which is deposited with the Colonial Trust Company as a trust fund against which each contract is a claim. This trust fund is maintained at about 75 per cent. of the total premiums written. A large part of the company's business is obtained from manufacturers themselves, who, instead of guaranteeing their machines for one year, turn over this feature to The Maintenance Company, the guarantee to the latter being, of course, of greater benefit to the user of the machinery than is the manufacturer's guarantee, as the latter is, as a rule, solely applicable in case any trouble which occurs can be proven to be due to an original defect, while the guarantee of The Maintenance Company is against all trouble. As the guarantee for the first year is, as a rule, extended by the user of the machinery, the company can well afford to make attractive rates to the manufacturers to induce them to turn over this troublesome feature of their business. The company now has something over 1000 machines under contract, largely in isolated plants.

The officers of the company are as follows: Jas. J. McKenna, president; Joseph M. Cooper, secretary, and Ernest R. Bartlett, treasurer.

Vertical Milling Machine.

That tool specialization may be carried too far has for some time been recognized, for against the advantages of special tools adapted for but one specific duty must be balanced the complexity which they introduce into workshops, the higher investment involved and the extra space occupied. If such tools can be kept constantly on one kind of work, their value is unquestioned, but otherwise the value of any tool is enhanced as its capacity for different varieties of work is enlarged. The milling machine illustrated herewith is claimed to possess the latter qualification to a high degree, the claim being made that no modern machine tool will perform with high economy so wide a variety of work.



BECKER-BRAINARD MILLING MACHINE.

Prominent features of this machine are its adaptability as a substitute for the planer and the lathe, and particularly the advantage in permitting the use of the efficient type of cutter employed. The facts that the work is kept below the cutter, firmly supported, easily gotten at and perfectly visible, are important considerations. It is possible with this type of machine to do either very delicate milling or to handle heavy work; it is thus a machine particularly suited to the general shop. It can be applied to intricate shape work, or with

a two-step cutter can be employed to work at both a recess and the upper adjacent surfaces to a uniform finish. As to operation, it is merely a matter of setting a cutter right, when an ordinary workman can run the machine. Moreover, as all the operating mechanism is within ready reach of the workman, his attention may be entirely concentrated upon the work itself.

As to construction, the spindle has long bronze bearings, adjustable for wear. The mills are secured rigidly by means of a drawbar, large surface mills being fitted to the nose of the spindle. The spindle driving pulley, which is mounted upon an adjustable auxiliary bearing, is back-geared five to one. To balance the action the back gears are in duplicate. The head has a movement of nine inches, which is either automatic or by hand. An automatic stop dog throws out the feed at any point within the limit of its vertical movement, thus making the tool an excellent vertical boring machine. A micrometer stop gauge located at the left-hand side of the frame accurately gauges the depth of cut.

The platen has an automatic feed in either direction and a quick return motion geared three to one. Channels cut into the table conduct lubricating oil into removable oil pockets. The saddle has the same length as the platen with an automatic feed in and out of 16 inches. Both feed screws are dialed. The knee has an automatic vertical feed. The rotary attachment has a graduated table, which is fed automatically in either direction. Adjustable conduits are attached to the periphery of the table to automatically trip the feed. The table feeds are derived from compounded gears, giving eight changes for each change of spindle speed. In addition, the intermediate gears on the rotary feed bracket are interchangeable, increasing the speed six to one, thus providing sixteen changes of feed for the rotary attachment. The arbor support is attachable to the knee and only used when side milling with long and slim cutters necessitates a spindle-end support. Vise jaws work in connection with the "T" slots of the table.

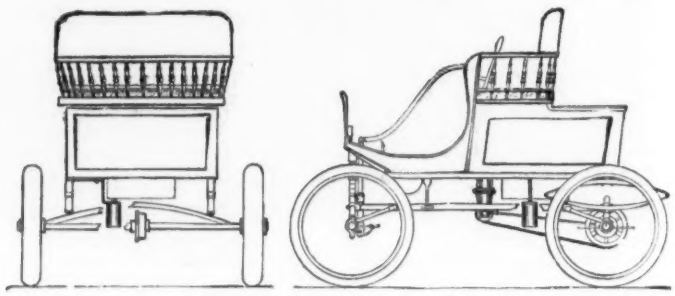
The spindle pulley is 16 inches in diameter with 4-inch face. The platen is 51½ inches in length over all and 14 inches wide, with a 42-inch automatic feed in either direction. The extreme distance between the spindle and platen is 21½ inches and between the spindle and rotary table 16 inches. The graduated table is 22 inches in diameter, and the face jaws are 9 inches long and 2½ inches deep. The countershaft has double friction pulleys 12 inches and 18 inches in diameter respectively, with 4½-inch face. The speed of the large pulley is 400 r. p. m., and that of the smaller pulley 100 r. p. m. The machine described is made by the Becker-Brainard Milling Machine Company, Hyde Park, Mass.

Electric Attachment for Steam Automobiles.

The steam automobile has become popular in many parts of the country, particularly outside of the cities, owing to its low price, lightness and ease of management. As is well known, propulsion is produced by a diminutive pair of steam engines operated by a very compact boiler heated by a bunsen burner. The gas employed in the burner is produced from gasolene under air pressure. The disadvantages attending the use of the vehicle are the necessity of having to stoop under it and by the aid of matches reignite the fire if it has been extinguished during a stop, or as is sometimes the case, if it becomes blown out by sudden gusts of wind when under way along the road. In the latter instance a stop is necessitated, as well as the match scratching business, above referred to.

The A. L. Bogart Company, of 123 Liberty Street, this city, which makes a specialty of electric gas lighting apparatus, has devised an electrical igniting attachment to obviate the disadvantages above referred to, which we illustrate as applied to that type of steam automobile known as the "locomobile." Figs. 1 and 2 represent the device as applied to the wagon, being respectively a rear and side view, and Fig. 3 is an enlarged diagram of the various details of the apparatus with the method of attaching the igniter. This latter is contained in a cylindrical case and consists of an electromagnetic vibrator carrying spark points which project through the bottom of the furnace, just above the upper surface of the burner. The igniter is supported by an iron brace *A B C*, secured to the under part of the wagon body at *D E* by screws *B C*. A push button is located at the right-hand side of the seat near the starting lever, so that it may be operated by the driver, either from within or without the wagon. A cylindrical case contains two cells of dry battery, which is placed in the tray in the front of the vehicle under the foot board.

A pressure of the button results in a spark being produced within the furnace which will ignite the gas when turned on. By the aid of this simple apparatus the fire may be reignited without stopping the vehicle, should it become accidentally blown out, while under way; furthermore, it admits of considerable economy in fuel, as the fire may be extinguished entirely whenever a stop is made, as the natural heat of the burner is sufficient to vaporize the gasolene from one and a half to two hourse after extinguishment. We are informed by the manufacturers that no technical knowledge is required in the installing of the device, as no alteration in any part of the vehicle is necessary.



FIGS. 1, 2 AND 3.—ELECTRIC ATTACHMENT FOR STEAM AUTOMOBILES.

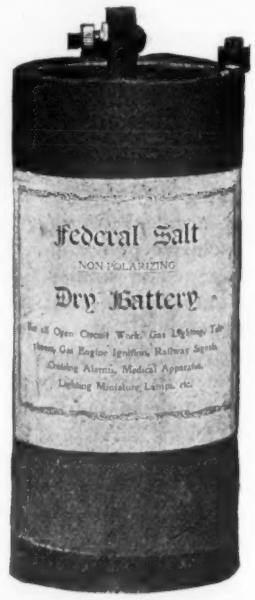
Federal Salt Dry Battery.

The Federal Battery Company, of New York, has commenced the manufacture of a new type of dry battery for which strong claims are made. The company supplies the following synopsis of a report made by a well-known battery expert:

A sparking test made with a Rhumkorff coil and one "Federal Salt" dry cell showed that a spark would jump across an atmospheric gap of ⅜ of an inch, while with a single cell of other makes it would only jump 1-32 of an inch, and with two in series only ¼ of an inch.

Another test of four of the new type of dry cells in multiple-series consisted in making 68 breaks a minute for 23 hours—9 hours one day and 14 hours the next. The coil was arranged so the spark would jump an atmospheric gap of ⅜ of an inch. During the entire run some 97,000 sparks were thrown across this gap without a single failure, and at the end of the test the electromotive showed no perceptible loss.

These cells are particularly recommended for gas engines and automobile work. On telephones, it is stated they have been used over 50 times a day for more than three months and still stand at 1.4 volts after resting over night.



FEDERAL SALT DRY BATTERY.

NEWS OF THE WEEK.

Financial Intelligence.

THE WEEK IN WALL STREET.—The bank statement last Saturday was a surprise on account of the small gain in cash holdings and of the large increase in loans. The result of the week's changes is a decrease of nearly two millions in the surplus. The appearance of the bank statement promptly upset some promising speculation for a rise. Until that time the market had been advancing, the gain in some stocks being very rapid. Brooklyn Rapid Transit had advanced 2⅛ points and Metropolitan Street Railway 2. The market for outside securities continued to show strength, and although there was some irregularity in prices in certain quarters of the market during the week, the general tone of trading was sufficiently strong to give confidence to those who had been predicting a lasting improvement in that market. Electric Boat common scored an advance of 4 points, and the preferred stock ended the week with a net gain of 13 points. These advances were due to reports to the effect that it was practically assured that the submarine boats manufactured by this company would be adopted by the Navy Department and that orders from the Government for a large number of these boats were very probable. New York Transportation was the most active and the strongest of the transportation stocks. It sold up to and above 14, and closed at 13¾ bid, a net gain of 3¾ points. On Saturday Electric Vehicle common enjoyed a sharp advance and ended the week with a net gain of 5 points. In this stock transactions amounted to only a few hundred shares. Electro-Pneumatic was traded in to a larger extent than any other issue, the daily transactions averaging probably not less than 15,000 shares. The trading resulted in an advance of 2½ points, most of which was kept till the close. The stock ended the week at 4¼ bid, a net gain of 2¼ points. Following is a synopsis of the week's trading in electrics: Brooklyn Rapid Transit was active, as indicated by the sales, which were 155,619 shares, the prices ranging from 71 to 76½, the closing price being 75⅞. The result was a net gain of 3 points. Erie Telephone was quiet, only 200 shares having been sold; the closing price was 103½. General Electric closed at 132½, which was the highest figure of the week, the lowest being 128½, thus representing a net gain of 4 points. The sales were 7665 shares. The sales of Metropolitan Street Railway were 18,836 shares, the closing price being 164, a net loss of 1 point. Third Avenue Railroad fluctuated between 102¼ and 105, closing at the latter figure. The sales were 4406 shares. Western Union ranged between 83¼ and 84¼, closing at 84, with a net loss of ⅛. The sales of this stock were 3785. New York and New Jersey Telephone closed at 166 bid, 175 asked. The closing quotation of Illinois Transportation was 2¼ bid, and 2½ asked. Union Traction in Philadelphia closed active on the strength of the favorable report of the company's earnings, but the electric securities relaxed all around. Electric Storage closed at 90 bid, 92 asked; do. pfd., 92; Electric Company of America 12⅛; General Electric Automobile 1; Philadelphia Electric 4¾; Philadelphia Traction 97 and Union Traction 40. In Boston, Bell Telephone closed strong at 314.

WESTERN UNION MORTGAGE.—The Western Union Telegraph Company has registered in New York a mortgage for $20,000,000 to run 50 years at 4½ per cent. The Farmers Loan & Trust Co. is trustee. The Western Union Building, New York, property at Fifth Avenue and Twenty-third Street, New York, and Chicago property are given as security. With the proceeds of the bond issue, 6 and 7 per cent. bonds to the amount of $5,861,000, maturing on May 1, 1900, will be retired, and $2,076,500 will be used to defray the cost of purchasing new lines, and for other obligations incurred from 1895 to 1899. The balance remaining out of half the bond issue, $10,000,000, will be applied to paying off debts contracted in the purchase of new lines and improvements since June 30, 1899. Out of the second $10,000,000 the real estate 7 per cent. bonds to the amount of $1,000.000, maturing on May 1, 1902, will be retired, while $9,000,000 will be held as a reserve by the Board of Directors to be applied solely for the improvement and extension of the property, and for the development of the business.

CONNECTICUT TRACTION DEAL.—The United Gas & Improvement Company, of Philadelphia, recently obtained control of some of the leading traction companies of Connecticut. General Manager Samuel T. Bodine, of the Improvement Company, says that the purchase includes the Bridgeport Traction Company, the Westport & Saugerties Street Railway Company, the Milton Traction Company, and the Shelton Street Railway Company. Mr. A. M. Young and ex-Lieut.-Gov. Wm. F. Shane, of New York, are interested in the deal—the former being president of the syndicate. The other officers are Randall Morgan, vice-president; Louis Lillie, secretary, and Walton Clark, general manager, the three last mentioned being also officers of the United Gas & Improvement Company. An officer of the latter company has said that the company expects similar success in the electric railway field that it has had in its operations with gas interests.

THE AMERICAN WIRELESS TELEPHONE & TELEGRAPH COMPANY, the main office of which is in Philadelphia, is offering stock for subscription. The capital stock is $5,000,000, consisting of 50,000 shares of a par value of $100 each. In the prospectus issued the Philadelphia company states that it is the sole owner of the letters patent for improvements in wireless telegraphy and telephony. The company also has patents pending in foreign countries. The officers of the company are as follows: G. P. Gehring, president; Wm. J. Moss, vice-president; Wm. Conly Reed, secretary; Henry S. Bass, treasurer; R. Leaman, George J. Jewell, A. R. Collins, directors; Ennis & Co., patent solicitors; W. S. Darnell, counsel; Prof. H. P. Davis, electrical engineer. It is said that the Philadelphia company is developing the Dolbear patents.

NEW ENGLAND ELECTRIC VEHICLE.—According to announcement on March 17 last, the annual meeting of the New England Electric Vehicle Transportation Company was held in Jersey City on April 3. It was voted that the capital stock of $25,000,000 be reduced to $5,000,000, divided into 500,000 shares of the par value of $10 each, the said decrease in the authorized capital stock of the company to be effected by reducing the par value and increasing the number of shares as aforesaid, and by purchasing at par the original 12 shares of fully paid stock of the company of the par value of $100 each by issuing from the unissued stock in lieu thereof and in payment therefor 120 shares fully paid of the par value of $10 each.

THE WALKER COMPANY.—A deed transferring the plant of the Walker Manufacturing Company, of Cleveland, to the Westinghouse Electric & Manufacturing Company was filed in the recorder's office in Cleveland a few days ago. The Westinghouse Company held the bonds of the Walker Company to the value of $1,175,000. On consideration of the surrender of these the Westinghouse secured the plant. The Walker Company had defaulted in the payment of interest and principal on the bonds. The Westinghouse Company assumes all the debts of the Walker Company, but the bills receivable are to be retained by the latter. The Westinghouse Company must also pay first mortgage bonds to the value of $850,000, now outstanding.

ILLINOIS ELECTRIC VEHICLE.—At the annual meeting of the Illinois Electric Vehicle Transportation Company, which was held in Jersey City on April 5, it was resolved to decrease the capital stock of the company from $25,000,000 to $2,500,000, divided into 250,000 shares of the par value of $10 each. By the adoption of the resolution it is stated that the interests of the shareholders will be served materially without in any way injuring the company. The following named gentlemen were elected directors: Samuel Insull, John J. Mitchell, Robert T. Lincoln, C. F. Kimball, C. K. G. Billings, Edward L. Brewster, Levy Mayer, Martin Maloney, H. P. Whitney, Robert McA. Lloyd, James E. Hays.

DIVIDENDS.—The Standard Underground Cable Company, Pittsburg, Pa., paid its regular quarterly dividend of 2 per cent. on April 10. The Consolidated Traction Company, of Pittsburg, has declared the regular semi-annual dividend of 3 per cent. on its preferred stock.

Commercial Intelligence

THE WEEK IN TRADE.—Reports received indicate a generally satisfactory condition of affairs in the business world. Bradstreet's says the industrial situation is a rather spotted one. April 1, instead of May 1, seems to have been fixed upon as a date for presenting new demands as to wages and hours. While many thousand men are directly or indirectly involved in the Chicago building trade strike, and several thousand are out in the coal industry in the Pittsburg region, most of the building trade strikers in other cities have gained their demands, and the machinists' strike at Chicago, which was regarded as threatening to the entire iron and steel industry, has been called off pending arbitration. While domestic trade shows signs of expansion, as indicated by noticeably large clearings last week, export business is likewise satisfactory. The total of exports from the port of New York last week made a new record, in being the heaviest aggregate reported in a month notable for

large totals. The iron and steel situation shows some effects of the recent missionary work in aid of lower prices, but results as yet are rather in the shape of unsettled feeling than of actually lower quotations. The failures during the past week, as reported by Bradstreet's aggregated 182, as compared with 178 the previous week. A significant and interesting fact is pointed out in that the failures were fewer and liabilities were smaller in the first three months of 1900 than in any corresponding period for eighteen years past. The copper market showed promises with very little metal available from first hands for nearby delivery. The quotations are 17 cents for Lake Superior ingot; 16⅞c for electrolytic and 16¾c for casting. The exports for last month aggregated 17,910 tons, being within about 3000 tons of the entire production for a single month. During the last four months the exports have averaged 15,000 tons. Railroad earnings for the fourth week of March show an aggregate of $9,325,121 on 40 roads, a gain of 15 per cent. over the same period a year ago.

NEW YORK EXPORTS OF ELECTRICAL MATERIAL.—The following were the exports of electrical material from the port of New York for the two weeks ended April 7: Antwerp—79 cases electrical material, $4428. Argentine Republic—1 case electrical machinery, $187. British Australia—55 cases electrical material, $2290; 2 cases electric motors, $280; 39 cases electrical machinery, $3875. Barcelona—2 cases electrical machinery, $34. Bremen—6 cases electrical material, $89. British Guiana—35 cases electrical material, $5075. Brazil—36 cases electrical material, $1348; 3 cases electrical machinery, $613. British East Indies—34 cases electrical material, $771. Berlin—2 cases electrical material, $611. Copenhagen—3 cases electrical material, $78. China—1 case electrical material, $61. Ecuador—4 cases electrical machinery, $18; 1 case electrical material, $32. Havre—20 cases electrical machinery, $1000. Japan—11 cases electrical material, $1651. Liverpool—274 cases electrical material, $21,296; 10 cases electrical machinery, $875. Lisbon—81 cases electrical material, $3042. Mexico—26 cases electrical material, $884. Newfoundland—2 cases electrical material, $89. Peru—26 cases electrical material, $914. Southampton—12 cases electrical material, $1769. Stockholm—3 cases electrical material, $130. Siam—13 cases electrical material, $285. Week ending April 7: Argentine Republic—49 cases electrical material, $6528. Antwerp—14 cases electrical machinery, $860; 53 cases electrical material, $3383. Amsterdam—11 cases electrical material, $1437. Brazil—33 cases electrical material $1716. Bristol—109 cases electrical machinery, $50,000. Bremen—2 cases electrical material, $27. British East Indies—113 cases electrical material, $5832. Barcelona—12 cases electrical material, $528. British West Indies—17 cases electrical material, $509. Cuba—876 cases electrical material, $7722. Chili—38 cases electrical material, $2546. Central America —14 cases electrical material, $412. China—31 cases electrical material, $1127. Dublin—77 cases electrical material, $20,855. French East Indies—5 cases electrical material, $123. Florence—4 cases electrical material, $42. Glasgow—210 cases electrical material, $3919. Japan—118 cases electrical material, $6029. Liverpool—97 cases electrical material, $6816. Mexico—49 cases electrical material, $3741. Puerto Rico—33 cases electrical material, $1070. Southampton—5 cases electrical material, $110. Stockholm—1 case electrical material, $115. U. S. Colombia—4 cases electrical material, $73. Vienna—2 cases electrical material, $57.

FOREIGN ORDERS.—The Morris Electric Company, of New York, has recently been awarded the following contracts by G. F. Greenwood, chief engineer and general manager of the Havana Electric Railway Company, who has lately returned to Cuba: One 50-hp engine with locomotive boiler, which will be supplied by the Edward P. Hampson Company, of New York, and a boiler of the same horse-power is being furnished through James Beggs & Co., of New York. It will be manufactured at the Erie Iron Works. The Eyeless Tool Company, of New York, is to supply 500 picks and a multitude of miscellaneous orders for track construction and small tools are now being given out by the Morris Company. The Lisbon Tramways Company, which is being financed by Wernher Beit & Co., of London, is also forwarding the Morris people a quantity of various orders. Three trolley wagons for construction work and four rail wagons have been contracted for with the J. A. McCardle Company, of Trenton, N. J. The trolley wagons are said to cost $750 each, while the rail wagons are valued at $860 apiece. An $8000 lot of machine tools, including car wheel borers from the Prentiss Tool & Supply Company, of New York; drill presses from the Garvin Machine Company, of New York, and a 400-ton hydraulic press from the Watson-Stillman Company, of New York, is now being ordered. The Morris Electric Company is also reported to be in the market for a 40-ton traveling crane and a number of orders aggregating in value nearly $5000 for picks, shovels, rail jacks, drills and track construction tools in general for the Lisbon road.

SMELTING GENERATORS FOR ENGLAND.—The Crocker-Wheeler Company has received another order for one of its 400-kw direct-connected generators and four 60-hp motors for the smelting corporation, Ellesmere Port, Cheshire, England. The value of the order is stated to be $13,500. The smelting corporation's electric equipment is said to be entirely of American manufacture, fully $100,000 having been expended in this direction. The Crocker-Wheeler Company secured the order for two 400-kw direct-connected generators and 20 motors varying from 12-hp to 100-hp; the Edward P. Allis Company, of Milwaukee, received the order for two 500-hp engines; the Crane Company, of Chicago, furnished the requisite piping, valves and so forth; the Connersville Blower Company, of Connersville, Ind., manufactured the pumps, while Wheeler condensers, also Hoppe feedwater heaters and separators are utilized.

MR. A. K. BAYLOR, of 18 Smithins Lane, London, who was formerly manager of the railroad department of the British Thomson-Houston Company, Ltd., returned to Europe this week by the Kaiser Wilhelm der Grosse after a five weeks' sojourn in the United States. His visit is stated to have been in the interests of various British electric roads. While here he made arrangements for the opening of an office at No. 508 Bowling Green Building, where he will be represented by his brother, W. Baylor, who, until recently, had charge of the New York office of the British Thomson-Houston Company. According to present arrangements Mr. Baylor intends to make another trip to America inside of two months.

CIRCUIT BREAKERS FOR FRANCE.—The Cutter Company, of Philadelphia, has secured a $5000 order for large circuit breakers which are intended for the Schneider Company's works at Creusot, France. The instruments are of various sizes and to break at from 1000 to 3000 amperes. The company has received Liverpool orders within the last few days for 31 of the same class of instruments to break at 500 amperes, and a London order calls for 34 breakers of a capacity from 45 to 1000 amperes.

AMERICAN STREET CARS IN SOUTH AFRICA.—That American street cars are growing in favor and becoming popular all over the world is being made evident almost every day by reports from widely separated localities. The latest evidence of this fact is an order on an American firm for several new surface cars for the Cape Electric Tramway Company, of Cape Town, South Africa.

ELECTRICAL EXHIBIT AT CHRISTIANIA.—A permanent exhibition of machinery has been opened in the City of Christiania, Sweden, to which manufacturers, agents and others are invited to send exhibits of their manufactures. A low rent is charged and appliances can be shown in operation without extra expense for driving power. For information the Alfheim Company, 22 St. Olafsgade, Christiania, may be addressed.

THE COMMERCIAL ELECTRIC COMPANY, of Indianapolis, reports that the demands on its factory products have never before been so great as they are this season. Its plant will have to be enlarged before attempting to accommodate the many foreign orders. The managers say they have recently shipped complete outfits of dynamos, motors, electrical apparatus, etc., to Yokohama, Japan; to Pueblo, Mexico, and to England.

THE GEORGETOWN POWER COMPANY, Georgetown, Col., is preparing to furnish mines in the upper section of Clear Creek County with electric power, as well as to several near Idaho Springs. Mr. L. Hanchett, superintendent of the Lamartine mine, is in the East buying machinery for that property and he will also act for the power company in buying additional machinery.

THE ROBERTS CHEMICAL COMPANY has signed a lease with the Niagara Falls Power Company for a half acre of land and 500 electrical horse power. The Chemical Company is organized under the New Jersey laws for the manufacture of various chemicals. Wesley S. Block, of New York, is president. Hydrochloric acid and caustic potash will be among the products of the plant.

THE ELECTRICAL LEAD REDUCTION WORKS at Niagara Falls were destroyed by fire on March 29. The directors had decided to put in additional machinery and make other changes which would have increased the output of the plant to 10 tons a day, but these plans were upset by the fire. Mr. C. J. Harrington, resident manager, states that the plant will be rebuilt.

THE WASHBURN WIRE COMPANY, which was recently organized, has, it is reported, secured 148 acres of land at Portsmouth Grove, R. I., where it will establish its works. The capital stock of the Washburn Wire Company is $1,500,000. The president of the corporation is Charles Washburn, of Worcester, Mass.

THE BALTIC COTTON MANUFACTURING COMPANY, of Plainfield, Conn., has borrowed $400,000 and is to build a large addition and start a cotton mill. An electric road will be built to Norwich.

NEW YORK ELECTRIC VEHICLE TRANSPORTATION COMPANY held its annual meeting Monday, April 9. Henry Sanderson was elected president, and James Joyce, Jr., vice-president.

Special Correspondence.

ENGLISH NOTES.

London Office, Electrical World and Engineer, March 24, 1900.

GLASGOW AUTOMOBILE EXHIBITION.—The motor-car manufacturers, to whom the Lord Provost of Glasgow recently explained the scheme of the Glasgow Exhibition, have definitely decided to support that event. The exhibit of each manufacturer will, however, be confined to not more than one vehicle of each type, as the expense of showing a greater number of cars for six months would be heavier than the present state of the industry warrants. The Council of the Exhibition will be asked to arrange for a special automobile week, during which a carnival may be held, to include automobile races, demonstrations of speed and control, etc. If the exhibition authorities see their way to organize this popular feature, the Automobile Club of Great Britain would probably arrange for a tour from London to Glasgow in connection with the event, thus securing great publicity not only for the exhibition, but also for the motor-car industry.

LAUNCH OF NEW CABLE STEAMER.—An interesting launch took place on the Clyde a few days ago, when Messrs. R. Napier & Sons, Limited, of Govan, near Glasgow, launched a twin-screw cable steamer of about 2500 tons for the Eastern Telegraph Company. The new steamer has been named "John Pender," and the usual toasts were given after the launch. The ship is 305 feet long, 41 feet broad, and has a depth of 26 feet 8 inches to spar deck. The upper deck is flush fore and aft, to obtain an unobstructed lead from the five cable tanks to the picking-up and paying-out machines at the bow and stern. The ship is thoroughly equipped with all the most recent cable gear, dynamometers, sounding machines, searchlight and a very complete installation of electric lighting with duplicate dynamos. The propelling machinery consists of two sets of triple expansion engines, having cylinders 22 inches, 35 inches and 58½ inches diameter respectively by three-foot stroke and three single-ended boilers for working pressure of 175 pounds, with the most modern appliances for efficiency and economy, including Howden's system of forced draught. The ship when finished will be the most complete cable steamer afloat.

MUNICIPAL TRADING.—Reference has been made in these columns from time to time to the increasing tendency of municipalities to enter into almost every kind of business much to the dissatisfaction of a great many of the ratepayers, with whom they are directly competing. In a great many cities municipalities control gas, electric lighting, tramways, water, and they are now going in largely for municipal telephones, and have commenced to manufacture various articles on a large scale. They have at last succeeded in stirring up the Associated Chambers of Commerce of the United Kingdom, and a meeting was recently held in London, at which many men of great influence were present. The subject of municipal trading came up for discussion, and it was resolved: "That this association considers it desirable that Parliament should define the limits of municipal trading, and, while regretting that Her Majesty's Government were unable to appoint the joint committee on municipal trading, which was promised by the leader of the House of Commons at the commencement of the session, 1899, trusts that effect may be given to his promise during the present session, 1900, and that pending the contemplated enquiry, no enlarged powers for trading purposes may be conferred on municipalities." The mover contended that the municipalities were now maintaining great monopolies while professing to work in the public interest. He stated that it was time for the association to protest against trades again being dominated by such a system. Another speaker made the statement that a strong conviction possessed the manufacturing classes of his own community that the constant and increasing encroachment of the authorities with public money into the domain of commerce was prejudicial to the wide and fundamental interest of the industries of this country. His own experience was that municipal trading was now progressing to a point of monopoly, and was oppressive to commercial freedom. It will thus be seen that now that the municipalities are entering into business where they will come into direct competition with ordinary manufacturers and business men that a severe and well-organized opposition will be made, and it is to be hoped that Parliament will soon take the matter up and decide as to just how far municipalities in this country can go, otherwise before long there will not be a line of business into which they do not encroach.

NEW ENGLAND NOTES.

Boston, Mass., April 9, 1900.

THE BOSTON ELECTRIC CLUB is being revived, or rather, it should be said, the title is being revived or resuscitated, in an organization just floated in the Hub.

ONE EFFECT OF HIGH PRICES.—Owing to the increased prices of all kinds of building material, the erection of dwelling houses in and around Boston, particularly in the suburban towns and cities, is practically at a standstill. This stagnation is being particularly felt by those local supply houses which handle domestic electrical material of all kinds. More than one electrical factory in Boston is now doing only a limited trade; but manufacturers of fan motors report fair business, in view of the approach of the warm season, when their special line of goods are bound to be in demand.

STREET RAILWAY FRANCHISE TAX.—In 1898 a bill was passed by the Massachusetts Legislature and subsequently became law, compelling all street railway companies doing business in the state to pay a franchise tax. The law has always been regarded as obnoxious and unjust by the different railway companies, and they have never allowed the matter to rest long, being determined to secure its repeal if possible. To that end a bill for the repeal of the objectionable law has been introduced before the House, and is at present under consideration. This, too, as might be expected, has aroused a good deal of opposition, and a determined fight is being made in the matter. Ex-Representative E. B. Callender, of Boston, who had charge of the Franchise Bill two years ago, now represents the remonstrants against its repeal. The various railway companies doing business throughout the State have their representatives looking carefully after their interests in the matter.

General News.

THE TELEPHONE.

FLATONIA, TEXAS.—A new telephone exchange is being put in here.

GAFFNEY CITY, S. C.—R. B. Davis will build a telephone line from Gaffney City to Sarratt.

MARSHALL, MO.—The Saline County Telephone Company will extend its toll lines to Grand Pass and Miami.

BLUFFTON, IND.—The United Telephone Company of this place has increased its capital stock from $50,000 to $75,000.

PETALUMA, CAL.—The Sunset Telephone Company is contemplating the extension of its lines in the vicinity of Petaluma.

TOPEKA, KAN.—The Waterville Telephone Company, of Waterville, Kan., made application for a charter. It has a capital stock of $1000.

GRANITE, ORE.—S. P. Haney contemplates the building of a telephone system to all of the important mines in the surrounding district.

ASHTABULA, OHIO.—The Ashtabula Telephone Company is preparing to rebuild and extend its system to accommodate its increased business.

ELKHART, IND.—Fifty farmers of this county have organized a telephone company. Twenty miles of wire will be strung, connected with 75 homes.

CHILDRESS, TEXAS.—The Panhandle Telephone Company is advertising for bids for material and construction of a telephone line 70 miles in length.

GREAT NECK, L. I.—The New York & New Jersey Telephone Company has leased a building on Middle Neck road and will establish an exchange here.

SIOUX FALLS, S. D.—A company composed of business men of Clear Lake has been formed for the purpose of putting in a telephone system at that place.

IDA GROVE, IOWA.—The Ida County Telephone Company, of Ida Grove, has been incorporated. Capital, $10,000. Incorporators: J. E. Conn, F. Brasted, both of Ida Grove.

NEW ORLEANS, LA.—There is some talk of organizing a co-operative telephone company in this city by the business men. The scheme is generally looked upon with favor.

PLAINFIELD, WIS.—The Union Telephone Company, of this county, is preparing to extend its line to Grand Rapids, a distance of 25 miles. Work will be begun at once.

PORT ARTHUR, TEXAS.—The Port Arthur Telephone Company has been incorporated. Capital stock, $5000. Incorporators: Sam Goldberg, George R. Stearns, C. Flannagan and others.

AKRON, OHIO.—The Akron People's Telephone Company has filed a mortgage for $150,000. It is given to the Dime Savings & Banking Company, of Cleveland, to secure a bond issue.

PORTAGE, WIS.—The Wisconsin Telephone Company intends to construct a line from Randolph to this city this summer. Another line will be built to Baraboo, by the way of Kilbourn.

MALTA.—Malta possesses a small telephone exchange, owned and operated by Mr. Robert Portelli, manager of the Malta station of the Eastern Telephone Company, which is now on the market for sale.

TONAWANDA, N. Y.—An effort to organize a Home Telephone Company in the Tonawandas has partially failed, and the men interested will aid the Home Telephone Company, of Niagara Falls, to get a franchise.

CEDAR RAPIDS, IOWA.—The Ozark Telephone Company, Cedar Rapids, has been incorporated. Capital, $30,000. Incorporators: D. E. Howell, C. L. Konvalinka, J. T. Crimmins, all of Cedar Rapids.

FAULKTON, S. D.—The Faulkton telephone exchange has been purchased by C. E. Warner. The line will probably be extended this summer eastward to Devoe, and from there to other parts of Faulk County.

RALEIGH, N. C.—The Raleigh Telephone Company has completed its organization with W. N. Jones, president; A. B. Stromach, vice-president; T. A. Armstrong, secretary and treasurer, and Will Wynne, manager.

LOUISVILLE, KY.—The Ohio Valley Telephone & Telegraph Company and the Cumberland Telephone & Telegraph Company have consolidated, increasing the capital stock $3,000,000, making the total capital of $6,000,000.

ROME, N. Y.—The Rome Home Telephone Co. has been incorporated to operate in Rome and the towns and villages surrounding in Oneida, Lewis and Madison Counties; capital, $150,000. Directors—John S. Wardwell, F. H. Shelley, and John E. Mason, Rome.

RACINE, WIS.—Allen Shewmon, who was recently granted a franchise to establish a new telephone system in Racine said that he had contracted for the material and that work of building the system would commence as soon as possible. He has guarantees for 433 telephones.

CHERRY FLATS, PA.—The Farmers' Mutual Telephone Company of Cherry Flats has been incorporated. Capital, $5000. Incorporators: T. J. Davies, E. C. Howell, both of Cherry Flats; E. D. Evans, of Wellsboro; E. C. Close, of Round Top; F. Peake, R. W. Bailey, both of Wellsboro.

PHILADELPHIA, PA.—A new telephone enterprise, not identified with the Telephone, Telegraph & Cable Company of America, is making preparations to enter Philadelphia in opposition to the Bell Company, through a subordinate company organized with Pennsylvania capital several months ago under the name of the Keystone Telegraph & Telephone Company.

MARION, IND.—Representatives of the Bluffton Independent Telephone Company, the Wabash Independent Telephone Company and the Marion Company held a conference in this city recently and perfected arrangements to construct and operate a toll line from Marion to Wabash.

DETROIT, MICH.—The Union Telephone Company seems to be strongly intrenched around Alma. Within a radius of 50 miles from the centre of the Union system one can talk to 148 towns, 70 of which the company occupies exclusively. The Union company expects to soon expend $25,000 in improving its present system and in putting up new lines.

ST. CHARLES, MO.—The Bell Telephone Company will begin work in a short time on the construction of a line from St. Charles to Boschertown and Orchard Farm. Besides the toll line through the counties of St. Charles, Warren and Lincoln, this company now has 75 telephones in operation in this city and expects to increase the number to 100 in the near future.

OMRO, WIS.—The Wisconsin Telephone Company is considering installing an exchange in this village. A franchise has been applied for. The Little Wolf River Telephone Company has a large exchange here, and has again established communication with Oshkosh. The Little Wolf Company maintains an excellent and cheap service in this vicinity, and has the support of the villages and cities that it connects.

CHARLESTON, S. C.—The Independent Telephone Company, of Bamberg, has been chartered. The corporators of the company are C. W. Garris, E. M. Mixon, T. L. Pearlstine, I. A. Sauls and Joseph Tobish. The capital stock of the company is to be $1000. The telephone line is to connect Branchville, Smoak's Lodge, Ehrhardt's and St. George's and may in time extend from these places.

NORFOLK, CONN.—The Southern New England Telephone Company has acquired control of the local telephone plant owned and operated by the Norfolk Electric Light Company. The control of the stock of the light company passed into hands friendly to the Southern New England Telephone Company. For some time the Electric Light Company has been operating a telephone exchange in Norfolk.

CAMBRIDGE, MD.—A controlling interest in the stock of the Dorchester Telephone Company has been sold to parties who own and control the Diamond State Telephone Company, as well as the Eastern Shore Telegraph & Telephone Company, of Caroline County. Harry Richardson, of Dover, Del., is president of these two companies and will be president of the Dorchester Telephone Company under the new regime.

INDIANAPOLIS, IND.—The Flat Rock Telephone Company, with a capital stock of $13,000, and the Jennings County Telephone Company, with a capital stock of $6500, have filed articles of association. The former will build a line in Shelby, Bartholomew, Johnson and Decatur counties. The directors are: Joseph Andrews, John Gaut, Thomas Wooley, A. W. Sanni and C. A. Swaile. The latter company will construct a line in Jennings County. The directors are: Charles Wright, D. L. Wright and William G. Rendrick.

WABASH, IND.—The Central Union Telephone Company, of this city, that cut rates to zero and in many instances furnished service free in opposition to the new home line, has removed the last dead head instrument and is now exacting the full price for its service. The effect is highly favorable to the New Home Company, which has successfully met this ruinous competition and paid its dividends. Work on the new toll line between this city and Marion began last week. This will give long distance connection with the principal cities of the state, including Indianapolis.

DENVER, COLO.—Local telephone service has been promised by the Colorado Telephone Company to a number of small Colorado towns, and the first steps toward the establishment of through lines from Denver to these points have been taken. Two districts of Colorado will be given this local service, including the towns of Silverton, Ouray and Delta, and the other including Sterling, Brush and Fort Morgan. As soon as material can be purchased the company will begin immediately to put in exchanges in these towns and string wires, franchises having already been obtained.

BOSTON, MASS.—Comparative figures, recently compiled, show that the growth of the Erie telephone system was the greatest in its line of business during the past year. The relative position of that system to the Bell telephone business of the United States is thus shown:

Growth for year 1899—	Entire U. S.	Erie System.
Increase telephones	455,255	89,623
Increase long distance wire mileage	115,921	25,552
Increase exchange wire mileage	240,000	44,437
Total increase wire mileage	355,921	79,989
Increase subscribers' stations	167,766	43,708
Cost of new long distance construction	$8,087,359	$1,946,312
Cost of new exchange construction	15,949,463	3,787,154
Total cost of new construction	24,036,822	4,733,466
Total amount of money invested	2,066,311	331,736
Total cost of additional real estate in telephone property	137,262,443	22,000,000

ELECTRIC LIGHT AND POWER.

BIRMINGHAM, ALA.—N. M. Chambless is in the market for electrical machinery for mining purposes.

SANTA FE, ARGENTINE.—The electric light station in this place now supplies current both day and night, and it has a good ventilating fan service.

BELLEVILLE, ILL.—There being no money in the treasury available to meet current expenses, the mayor, on April 3, ordered the electric light service shut off.

POMONA, CAL.—The Sierra Power Company has been incorporated here with a capital stock of $75,000. The directors are E. G. Baldwin, J. Albert Dole, A. W. Burt and others.

EPHRAIM, UTAH.—Steps are to be taken at once to secure the control of a power site at the mouth of a canyon for the purpose of establishing an electric light plant for the city.

TUNIS, AFRICA.—The erection of a central station plant is being discussed in Tunis, which has not yet had any of the advantages of electricity, the small tramway there being operated by animal power.

CINCINNATI, OHIO.—Bert L. Baldwin, of Cincinnati, is receiving bids for complete equipment of the light and power plant to be installed in the new establishment of the U. S. Card Playing Co, in Norwood.

HEALDSBURG, CAL.—The new municipal electric lighting system recently installed here under contract with John Martin, agent of the Stanley Electric Manufacturing Company, has been accepted by the town authorities.

CHIHUAHUA, MEX.—The contract for the erection of a new electric light plant to be located here has been awarded to Frey, Dean & Co. The machinery has all been purchased, and will be installed as soon as the building is ready to receive it.

NEW ALBANY, IND.—The New Albany Light & Power Company was recently incorporated. The capital stock is placed at $25,000, and G. E. Steinhauer, George Borgerding, E. M. Birod, C. O. Kelso and C. D. Knight, are the directors.

BOONVILLE, MO.—The deal has been closed whereby the controlling interest in the Boonville Electric Light Company passed into the hands of W. A. Sombart, of the Sombart Gas Company, who purchased it of C. H. McCullough for the sum of $8200.

ST. LOUIS, MO.—The Seckner Contracting Company, of Chicago, closed a deal, April 3, for the location of a site for its new lighting plant on Commercial Street, at the foot of Le Baume Street. Work will be begun immediately on the erection of the plant.

BUENOS AYRES, ARGENTINE.—Mr. Scharrer, who secured the concession for the electric light plant in Rosario, has formed a company in Germany with a capital stock of 3,000,000 marks to operate the same. The lines of the new company will be laid under ground.

SANTA FE, N. M.—A company with $50,000 capital has acquired the electric light plant here, against which there is a judgment of $40,000. I. M. Sparks, local manager of the telephone exchange, was appointed superintendent of the electric light works, succeeding Capt. S. H. Day.

SOUTH BEND, IND.—The St. Joseph & Elkhart Power Company has began preparations at South Bend, Ind., for the construction of a dam in the St. Joseph River. Four thousand electrical horse power will be conveyed to and sold in South Bend for manufacturing purposes.

PITTSTON, PA.—The Merchants & Manufacturers' Electric Light, Heat & Power Company, Pittston, has been incorporated to supply light, heat and power. Capital, $10,000. Incorporators: W. F. Hallstead, E. M. Stack, M. W. Collins, G. M. Hallstead, F. C. Hand, all of Scranton.

STOCKTON, CAL.—The Golden Gate Mining, Milling & Power Company has been incorporated here. The directors are: A. Heinzelmann, William Schwartz, Angels Camp; M. S. Thresher, G. C. Turner and F. C. Turner, Stockton, and George Babb, Irvington. Capital stock, $100,000; subscribed, $60,000.

PITTSBURG, PA.—The finishing touches are being given the power house of the Monongahela Light & Power Co., at Rankin, and the whole will probably be completed within six weeks. When finished there will be eight Sterling boilers of 600-hp each, and an equal number of Westinghouse dynamos of 550 volts each.

REDDING, CAL.—Local capitalists contemplate installing an electric power plant on the Pit River and a company is now being formed for the purpose. The idea is to establish a plant to furnish electrical power to the mines of Shasta County and to light Redding. Among those interested are R. M. Saeltzer and Fred Hurst.

CHICAGO, ILL.—It is stated that the People's Gas Light & Coke Company has purchased the Ogden Gas Company and the Cosmopolitan Electric Company. It is thought that the price paid for the purchase of these properties was about $6,000,000. By means of the Cosmopolitan Electric Company's franchise the People's Company may become a rival of the Chicago Edison Company.

ST. LOUIS MO.—The Imperial Electric Light, Heat & Power Company filed a mortgage deed on its St. Charles Street property in favor of the Continental Trust Co., of the city of New York, and Louis Chauvenet, who are made trustees for the bondholders. The purpose is to secure the payment of bonds to the amount of $1,000,000, with the privilege of increasing the amount $500,000 more if desired.

ANDERSON, IND.—Several years ago this city bought from the Anderson Electric Lighting Company the Commercial electric lighting plant at a cost of $32,000, which, with interest for 12 years, amounts to $48,000, payable yearly in notes of $4000 each. The city has just paid $14,000 of the debt, every cent coming from the earnings of the plant, and there is left in the fund $7000. This is the result of two years' municipal control.

ST. LOUIS, MO.—The City Lighting Company, the local branch of the Seckner Contracting Company, of Chicago, which has secured the electric lighting contract from the city, filed articles of incorporation March 30, placing its capital stock at $600,000, one-half paid up. The incorporators are John H. Brown, Robert M. Shaw, George Mayor, E. M. Tyner and M. C. Bingman. The company will build its own plant to carry out its contract and will not affiliate with any local electric concern.

OPELIKA, ALA.—Some wealthy capitalists of Montgomery, Ala., have organized a new electric light company in this place. It will be operated in competition with the existing one, the Opelika Electric Light & Power Company, which furnishes the town with 22 enclosed arc lights and furnishes current for about 1000 commercial incandescent lamps. The contract price for street lighting is $100 per year per lamp. For commercial service the rate is 75 cents per lamp per month, flat rates. Mills and factories are supplied by meter at 15 cents per kilowatt hour.

COLUMBUS, OHIO.—The state board of public works has granted to F. M. Joyce, of Detroit, Mich., the privilege to experiment with the electric pro-

pulsion of canal boats on the Miami and Erie Canal, and he will be permitted to select a stretch of 10 miles near Toledo, on which to test his system. The work is to begin within a year and two and one-half years are given in which to make the experiment. If he succeeds, he is then to be given the opportunity to operate his boats on the canal between Dayton and Cincinnati for the period of 25 years, he to pay the regular tolls for the privilege.

DENVER, COLO.—A lively rate war has begun between the Lacombe Electric Company, which has just been granted an electric light franchise, and the old company, the Denver Gas & Electric Company, which has heretofore had control of all electric lighting for both private consumers and the city. The latter company has heretofore claimed that it could not afford to reduce its rates, even though threatened with competition, and this statement was doubtless true with the plant which it had—far from up to date. It is now stated that the company will soon begin to expend $500,000 on the improvement of its plant, so that the company will be in a position to meet the cut rates of the Lacombe Company as soon as the latter's station can furnish current. On April 1 a reduction of 10 per cent. in gas and electricity went into effect.

THE ELECTRIC RAILWAY.

NIAGARA FALLS, N. Y.—The Niagara Gorge Railroad is expected to resume the operation of its line May 1.

LOGANSPORT, IND.—The Logansport Traction Company has increased its capital stock from $100,000 to $1,000,000.

AVA, MO.—The board of trade of Ava is agitating the question of an electric railway from this town to Cedar Gap, a distance of 10 miles.

BERLIN, ONT.—It is said that the Preston & Berlin Street Railway Company will build a line between the towns of Berlin and Preston, Ont.

SANTIAGO DE CHILE.—The first electric tram car ever operated in this city went over the lines on April 1. Popular interest in the event was keen.

DETROIT, MICH.—The Detroit, Utica & Romeo Electric Road has contracted for the construction of 12 miles of track to be finished early in the summer.

DALLAS TEXAS.—Work has begun upon the electric line between Dallas and Fort Worth, which is being promoted by George T. Bishop and others, of Cleveland, Ohio.

PHILADELPHIA, PA.—The Millville Traction Company is preparing for the opening of its line from Millville to Vineland, and expects to have it completed by July 4.

DALEVILLE, IND.—A franchise has been granted by the town council of Middletown to the Union Traction Company, to build and operate a street railway over the streets of that city.

MARINETTE, WIS.—The town of Peshtigo has granted a franchise to the Marinette street railway to build a line from here to that town. It will be eight miles long and will cost $80,000.

ABINGDON, VA.—It is reported that the present owners of the Abingdon & Damascus Electric Railway have completed their plans for an extension to a point in Johnson County, Tenn. Robert Gray is engineer.

DETROIT, MICH.—Messrs. Smith, Sawyer and Taylor, promoters of the Pontiac & Flint Electric Railway, were granted a franchise for a track on Oakland Avenue, between Johnson Avenue and Saginaw Street.

SAN JUAN, PUERTO RICO.—Secretary Root on April 7 gave the San Piedras Railway Company of this city authority to change its motive power to electricity, and to sell electricity to the city for illuminating purposes.

NEWARK, N. J.—The electric cars of the Westtfield & Elizabeth Street Railway Company, in conjunction with the Plainfield Street Railway Company, will be running direct from Plainfield to the Elizabeth city line in a few days.

MARSHALL, MICH.—The council has granted a franchise for an electric railway through the city to the Kalamazoo River Valley Electric Company. The company proposes to build a road between Battle Creek to Jackson this year.

PORT CHESTER, N. Y.—The highway commissioners have granted a franchise to the Port Chester Street Railway for an extension of its tracks through the towns of Rye and Harrison to Mamaroneck, paralleling the New Haven Railroad.

SHELBYVILLE, IND.—The Shelbyville Street Railway, Light & Power Company has been incorporated. Capital, $25,000. Incorporators: J. D. Pugh, J. A. Tindall, E. K. Adams, A. J. Murston, J. H. Akers, A. Deprez, all of Shelbyville.

TAUNTON, MASS.—James Murphy, of Somerset, has been appointed assistant superintendent of the Taunton & Dighton, Somerset & Swansea Street Railway companies, recently made vacant by the death of the Late George L. Southworth.

ROCHESTER, N. Y.—The Rochester & Sodus Bay Railroad Company, having failed in its effort to obtain consent of all property owners for extending its line in the town of Sodus, have begun condemnation proceedings against a number of the owners.

RICHMOND, VA.—The Richmond Passenger & Power Company has filed with the city engineer plans for the rehabilitation of the Richmond Railway & Electric Company's property. These plans propose some radical changes in the arrangement of the lines.

ASHEVILLE, N. C.—E. R. Bliss, of Chicago, has purchased the Intermontane Street Railway and will extend it to Weaverville, a distance of six and one-half miles. Water power will be secured from Baird's Falls, which, it is expected, will develop 300-hp.

BAKERSFIELD, CAL.—The Bakersfield & Kern Electric Railway Company was recently incorporated. The directors are: C. R. Eager, San Francisco; S. B. Cushing, San Rafael; H. A. Blodgett, C. N. Beal and F. T. Whorff, Bakersfield. Capital stock, $250,000; subscribed, $5000.

CHAPEL HILL, N. C.—A committee has been appointed to promote the proposed electric railway between Chapel Hill and Durham, a distance of 12 miles. Among those interested are John M. Carr and C. L. Lindsay, of Chapel Hill; also W. K. Peckham, of New York.

BUFFALO, N. Y.—The original subscription of the Buffalo Railway Company to the Pan-American Exposition stock was $50,000, and the allied lines gave an additional $11,000. Now the International Traction Company has made the total of its subscription a round $100,000.

NASHVILLE, TENN.—The People's Railway Company, just chartered, proposes to construct and operate electric lines over various streets in the city and suburbs out to the National cemetery, six miles northeast; to Paradise Ridge, 15 miles north, and to Franklin, 18 miles south.

EAST ST. LOUIS, ILL.—A franchise was granted, March 29, by the county board of St. Clair County, Ill., for a new electric railway between East St. Louis and Millstadt. The franchise was granted to W. I. Mayo. Mr. Mayo represents the St. Louis & Southeastern Electric Railway Company.

WORCESTER, MASS.—The transfer of the stock of the Worcester & Marlboro, which has lately been acquired by the railway syndicate, has been made through the Citizens' National Bank. The shares of the Marlboro road were deposited in the Worcester bank, and turned over to the Old Colony Trust Company.

BOSTON, MASS.—The selectmen of Westwood have granted the Norwood, Canton & Sharon Street Railway Company a location, and the company has accepted it under the conditions imposed. The road must be completed May 1, 1901, and there are forfeits attached in case of failure to begin or to complete the work on time.

DENVER, COLO.—On March 31, the operation of the only remaining cable street railway in this city was discontinued, and the trolley system substituted therefor. This was on the Larimer street line. Denver had one of the most extensive cable systems in the United States, but this method of propulsion has completely given way to the trolley system.

HAVRE DE GRACE, MD.—The Bel Air & Havre de Grace Electric Railway & Power Company, a bill for the incorporation of which was recently introduced in the Maryland Legislature, will need new equipment, including engines, boilers, generators, water wheels, wire, cars, ties, rails, storage battery plant, etc. Mr. John H. Reckord, Bel Air, Md., may be addressed on this subject.

ST. LOUIS, MO.—Brown Bros. & Co. could not secure the assent of 80 per cent. of the certificate holders to their proposition for an extension of one year on their street railway option and the distribution of the unsold bonds and stocks will therefore be made as agreed, the bonds on April 12 and the stocks on April 19. After that date they will have no further connection with the street railways of St. Louis.

INDIANAPOLIS, IND.—The Indianapolis & Martinsville Electric Railway Company has let a contract to the Delaware Construction Company to build the grade and bridges for its line between the two cities. The power house is to be located at Waverly, where water power will be used. Plans for the dam and power house have been made, and this contract will be let soon also. Daniel Leslie, of Indianapolis, is the president.

HARRISBURG, PA.—A charter was granted at the State Department to the Ohio Valley Electric Street Railway Company, to build a line 11 miles long, from Vanport, Beaver County, through Industry and Ohio townships, to Glasgow. The capital stock is $70,000, and the directors are Harry C. Eagle, Henry Fitzpatrick and John Gallagher, of Pittsburg; Harry M. Reeves, Beaver Falls; Oliver B. Elliott, Billowville, and Edwin S. Weyand, Beaver.

CHICAGO, ILL.—The employees at the power house of the Chicago City Railway Company quit work on April 6. The men quit voluntarily, and did so because they objected to being asked to work 12 hours a day. All of the south side lines, involving 200 miles of track, were tied up at intervals. Thousands of south side citizens were delayed more or less in reaching their homes because of the strike, which at last accounts was still on.

CINCINNATI, OHIO.—The Cincinnati Street Railway Company has practically decided to use storage batteries as a means of relieving the loads on the generating machinery. Two storage battery plants will be installed, one at Depot Street, at the foot of Price Hill, and the other at the Hunt Street power plant. The company has been investigating the practicability of these batteries which are in use by the street railways of Pittsburg, Chicago, Germantown, Pa., and other cities, and is satisfied that the outlay necessary will be a good investment.

JERSEY CITY, N. J.—The North Jersey Street Railway Company and the Consolidated Traction Company held their annual meetings in Jersey City a few days ago. There were no changes in the North Jersey, all of the old directors and President E. F. C. Young and all the old officers being re-elected. The Consolidated Traction Company, whose lines are leased to the North Jersey Company, re-elected all its old directors and officers, except that E. F. C. Young was chosen to succeed the late Bernard M. Shanley, both as a director and as president of the company.

DENVER, COLO.—The Denver, Boulder & Northern Railway Company, which asked a franchise of the city, has retired from the field. The officers say that there seemed to be a disposition to load the ordinances with so many amendments which would hamper the company that it was unwise to attempt the operation of the road. The company proposed to build an electrically operated railway from Denver to Boulder, 25 miles north of this city, in the foothills, with branches leading to towns in the Clear Creek Canon on the one side and to Greeley on the other.

DENVER, COLO.—The Denver City Tramway Company made a remarkable record in equipping its cable lines for electric operation. The ordinance authorizing the change was passed on March 20; all five roads which had been operated by cable cars were in regular operation by motor cars on March 31. The finishing touches, of course, had not been given to the construction, but the roads were in good working order and were operated on schedule time. In making the improvement the company is expending $250,000, but three-quarters

of a million dollars is to be spent in the general improvement of the general railway plant.

CHICAGO, ILL.—In connection with the decision of the Chicago Electric Traction Company, to substitute the trolley system on its storage battery lines, it is stated that the abandonment of the storage battery system was due chiefly to the mechanical difficulty in charging the batteries in cars on branch lines, which do not run to the central power house. The system is said to have worked very satisfactorily on single lines, but since the road has been acquiring branches it has proved both cumbrous and expensive. The road runs through a sparsely settled neighborhood, except at its terminals, and it has not yet been able to maintain more than one power house. The storage battery system was installed three years ago. The company was formerly known as the Chicago & Englewood line.

THE AUTOMOBILE.

KENOSHA, WIS.—E. B. Boyington, president of the Lehigh Valley Automobile Company, is trying to organize a company here, with $100,000 capital, to operate a line of automobiles.

COLUMBUS, OHIO.—The Columbus Transfer Company is negotiating with an eastern concern with a view to purchasing several automobile broughams to be placed in its regular day service.

BELLEFONTAINE, OHIO.—The owners of Indian Lake Park at the Lewiston reservoir will operate an automobile bus line this summer between the various towns on the bank of the reservoir.

AUTOMOBILES IN VISALIA, CAL.—Visalia, Cal., will have an electric automobile service, which will provide for daily trips to and from Exeter, Lindsay and Porterville. A. G. Wishon is the promoter of the company.

THE UNITED STATES LONG DISTANCE AUTOMOBILE COMPANY has been incorporated at Elizabeth, N. J. The authorized capital is $1,000,000. The incorporators are Lewis Nixon, John C. Fremont and David J. Newland.

THE SCHAUM AUTOMOBILE & MANUFACTURING COMPANY, recently incorporated at Baltimore, will establish a factory for manufacturing automobiles and supplies of every kind pertaining to the construction of automobiles and small steam launches.

THE NATIONAL AUTOMOBILE COMPANY, Indianapolis, Ind., has completed one-story of its main building. The plant will be ready for operation May 1. President Dow says the company has many orders to begin on and they are working on a hurry-up pace.

GENERAL CARRIAGE.—It is stated that the General Carriage Company has made an arrangement with Messrs. Frohman, Rich and Harris to inaugurate a system whereby all the theatres in New York will provide a scheme of carriage calls at the box offices at uniform rates.

AUTOMOBILE CHARGING STATION.—The People's Light & Power Company, Newark, N. J., has provided facilities at its Mechanic Street station for charging electric automobiles at any voltage. The batteries can be charged from cords and plugs conveniently arranged, and meters especially arranged for the purpose will show the quantity of current supplied.

THE NEW YORK ELECTRIC VEHICLE & TRANSPORTATION COMPANY has obtained the right to operate automobiles on every street of New York City by a bill passed in the assembly at Albany a few days ago. The bill has already passed the senate and now goes to the Governor, who is expected to sign it. Automobiles will be put on Fifth Avenue within a few weeks to replace the stages.

AUTOMOBILES IN HONOLULU.—The Honolulu (H. I.) automobile hack system will soon be in operation. Twenty-one of the vehicles are now on the way to the islands and the balance of the order will soon be completed. Louis T. Grant, the electrician, will be manager of the company, which will use electric vehicles exclusively. Some very elegant automobiles will be kept, also, for hire to tourists and fashionable natives.

THE NEW ENGLAND ELECTRIC VEHICLE COMPANY, of Boston, has filed with the commissioner of corporations the following certificate of condition as of March 1, 1900: Assets—Buildings, $163,350; machinery, $112,718; other assets, $363,643; cash and debts receivable, $1,484,063; stock in process, $2630; patent rights, $25,000; miscellaneous, $109 350; balance profit and loss, $13,478; total assets, $2,274,236. Liabilities—Capital stock, $2,242,600; debts, $31,636; total liabilities, $2,274,236.

WASHINGTON, D. C.—The Baltimore & Ohio Railroad has established electric automobile service in this city, in connection with its train service, being the first railroad to introduce this mode of transportation regularly to and from its railway station. The vehicles are provided with luxuriously deep-cushioned seats, with electric lights and timepieces. Two small trunks can be carried on the supports at the rear of the vehicle, and the top of the cab provides ample room for small traveling bags and hand luggage.

LEGAL.

WESTERN TELEPHONE CONSTRUCTION COMPANY.—The Chicago Title & Trust Company has been appointed receiver for the Western Telephone Construction Company. The appointment was made on the application of the Varley Duplex Magnet Company.

THE FORT WAYNE ELECTRIC CORPORATION.—A. A. Chapin, referee in bankruptcy, announces that the uncollectible notes, accounts, contracts and other evidences of indebtedness belonging to the bankrupt Fort Wayne Electric Corporation, Fort Wayne, Ind., will be sold by the trustee on April 14, in that city, to the highest bidder for cash.

THIRD AVENUE'S AFFAIRS.—As a result of the amount of litigation involved in the settlement of the Third Avenue Railroad affair, it was decided in the United States court to refer all outstanding suits for money due under contracts previously had with the Third Avenue Company by referring them directly to Receiver Grant. This was done in a suit brought by the Old Colony Trust Company on behalf of certain creditors of the Forty-second Street & Manhattanville branch of Third Avenue.

TELEPHONE DECISION.—The New London (Conn.) Telephone Company several months ago petitioned the Superior Court to approve its necessity and convenience under the statute. The petition was fought by the Southern New England Telephone Company in a long trial. Judge Thayer, at New Haven, has just rendered a decision denying the application. The case is looked upon as one of great importance, as establishing a precedent in Connecticut. The new law compels all proposed companies to ask the Supreme Court to pass upon the necessity for the service.

DIEHL FAN PATENTS SUSTAINED.—The patent litigation of the Diehl Manufacturing Company, of Elizabethport, N. J., which has been pending against Royce & Marean, of Washington, D. C., for some time, has been settled in the favor of the Diehl Company. The suit, which was brought in the Supreme Court of the District of Columbia at Washington before Associate Justice Charles C. Cole, was decided on March 8. The defendants thoroughly contested the questions of infringement, interpretations of claims, invention and novelty of invention and validity of the patents in suit, and the case was argued both orally and in print by the opposing counsels. The order and decree of the court is as follows:

1. That letters-patent of the United States granted to Philip Diehl and Edwin H. Bennett, Jr., for improvements in electric fans, dated Dec. 15, 1891, and numbered 465,360, are good and valid in law; that the said Diehl and Bennett were and are the original, first and joint inventors of the invention described and claimed therein; that the title thereto and to said invention is vested exclusively in the complainant; that the defendants have infringed on claims 1 and 2 of said letters-patent and on the exclusive rights of the complainant under the same.

2. That letters-patent of the United States granted to said Philip Diehl for improvements in oil guards for electric fans, dated April 16, 1895, and numbered 537,679, are good and valid in law; that the said Diehl was and is the original, first and sole inventor of the invention described and claimed therein; that the title thereto, and to the invention described and claimed therein, is vested exclusively in the complainant; that the defendants have also infringed upon the same and the claim thereof and on the exclusive rights of the complainant under the same.

3. That letters-patent of the United States granted to Edwin H. Bennett, Jr., for combined electric fan and electrolier, dated June 29, 1897, and numbered 585,250, are good and valid in law; that the said Bennett was and is the original, first and sole inventor of the invention described and claimed therein; that the title thereto and to the invention described and claimed therein is vested exclusively in the complainant; that the defendants have also infringed upon claims 1 and 5 thereof, and on the exclusive rights of the complainant under the same.

4. That a perpetual injunction be issued in this suit strictly commanding and enjoining said defendants, and each of them, and their servants, agents, attorneys, employees, workmen and confederates, and each and every one of them, from directly or indirectly making, constructing, using, vending, delivering, working or putting into practice, operation or use, or in anywise counterfeiting or imitating the said inventions as set forth in said claims 1 and 2 of said patent No. 465,360, said claim of said patent No. 537,679 and said claims 1 and 5 of said patent No. 585,250, or either of said claims.

5. That the said complainant do recover of the defendants its costs and charges in this suit to be taxed.

6. And forasmuch as there is no proof that the defendants were notified of said infringement prior to the commencement of this suit, either actually or constructively, and as no damages nor profits have been proved, it is further ordered, adjudged and decreed that this decree be without the recovery from the defendants of any profits or damages received or sustained by reason of said infringement.

PERSONAL.

MR. JOHN H. ROBERTSON, superintendent of the Third Avenue Railroad, New York, has resigned that position. He was with the company 33 years

GUSTAV SCHIMPFF, of Berlin, Germany, royal government engineer, who is in this country as the representative of the German minister of public works, recently visited the power plants at Niagara Falls.

MR. PHELAM McCULLOUGH, chief electrician of the Toronto Electric Railway, will leave shortly for Liverpool, England, to take the position of electrician to the Liverpool street railway, which is operated by the council of that city.

MR. DANIEL MULQUEEN, cashier of the Toronto Electric Street Railway, has been appointed manager of the street railway and other enterprises of the Mackenzie Syndicate at San Paulo, Brazil, and will leave for that place in a short time.

MR. IRA McCORMICK, who has been prominently connected with street railways in Brooklyn and Syracuse, assumed the position of general manager and superintendent of the lines operated by the Cleveland Electric Railway Company, Cleveland, on April 1.

MR. HENRY HINE, who has been general manager of the Stanley Electric Company, Pittsfield, Mass., since its incorporation in 1891, has resigned his position, to take effect the first of May. It is reported that Mr. Hine will move with his family immediately to Colorado Springs, Colo., where he has extensive electrical interests, which will now receive his entire attention.

MR. W. S. GORTON, who for the past year has been general manager of the interests of both the Standard Tool Company and the Standard Welding Company, Cleveland, Ohio, has resigned from his position with the former company and will devote his entire attention to the interests of the latter company. Mr. H. A. Higgins, formerly in charge of the electrical wire department of the American Steel & Wire Company at Chicago, has succeeded Mr. Gorton as general manager of the Standard Tool Company.

OBITUARY.

B. D. HALL, president of the American District Steam Company and a prominent citizen of Lockport, N. Y., died at his home in that city on Sunday last at the age of 70 years.

Trade Notes.

FIRE on the morning of April 7 damaged the works of the H. W. Johns Company, at 82 Washington Avenue, Brooklyn, to the extent of about $5000. The loss on the stock is said to be about $1000.

THE U. S. MINERAL WOOL COMPANY has removed from 2 Cortlandt Street to 143 Liberty Street, New York. The new headquarters will afford every facility for handling the company's rapidly growing business with the greatest convenience and despatch.

METAL POLISH.—George W. Hoffman, 295 East Washington Street, Indianapolis, Ind., is sending out samples of "U. S." Metal Polish Paste for polishing all manner of smooth metal surfaces. The polish is stated to be easily applied, is non-injurious and produces a brilliant and lasting luster.

MELDRUM FURNACES.—In a 24-page pamphlet Meldrum Bros., of Manchester, England, describe the Meldrum furnace, of which 6500 are stated to be now in use. This furnace is especially adapted for low class fuels, and has been used in connection with a number of dust destructor plants in Great Britain.

THE FALCON ELECTRIC MANUFACTURING COMPANY, 432 East Seventy-first Street, New York, has issued a new price list of its standard switch and fuse panel boards. Among other bulletins which have been recently issued by this company are one on Falcon knife switches, another on Falcon receptacles and a third on Falcon fan motors.

THE EMERSON ELECTRIC MANUFACTURING COMPANY reports from its New York office, at No. 136 Liberty Street, that the first load of fan motors and ceiling fans have been received from the St. Louis factory. Further shipments will follow, and a large and complete stock of fan motors will be kept on hand in New York during the entire season.

THE FERRACUTE MACHINE COMPANY, of Bridgeton, N. J., will have three exhibits of presses, dies and other sheet metal machinery at the Paris Exposition—the main exhibit, Block 8, American Machinery Department, Champs de Mars; coining machinery, United States government exhibit, Champs de Mars, and heavy machinery in Block 5, Machinery Annex, Vincennes.

HURD & CO. is the name of a new firm of engineers and machinists which has acquired the shop formerly operated by the Century Machine Company, 570 to 576 Broadway, New York City, for the purpose of model and toolmaking and experimental electrical work. The head of the firm is Mr. B. Hurd, a graduate of the Massachusetts Institute of Technology, and a skilled mechanical and electrical engineer.

MECHANICAL DRAFT.—The B. F. Sturtevant Company, Boston, Mass., has issued as a supplement to its pamphlet, "Who Uses Mechanical Draft," a list of the forced and induced draft plants which the company has installed during 1899. This list, which does not include stationary plants, bagasse burners, marine installations or apparatus sold to manufacturers of mechanical stokers, occupies almost five closely printed octavo pages, and includes a large number of central station and electric railway plants.

ELEVATOR ELECTRIC SIGNALS.—The Elevator Supply & Repair Company, 136 Liberty Street, New York, has issued a handsomely illustrated pamphlet describing the Armstrong electric signals for passenger elevators. This system has been introduced in most of the more recent large office buildings in New York, where it has given much satisfaction. A noteworthy feature of the various devices used with the system is their artistic appearance, much care having evidently been bestowed in this direction.

THE BURT MANUFACTURING COMPANY, of Akron, Ohio, manufacturers of the Cross oil filters, recently entered its twelfth order from the National Steel Company, the twelfth from the American Tin Plate Company, ninth from the American Steel & Wire Company, seventh from the Federal Steel Company, fourth from the Pittsburg Plate Glass Company, fourth from the Calumet & Hecla Mining Company, and duplicate orders from the Cambria Steel Company, Diamond Match Company, and National Cash Register Company.

TREATISE ON WOOD PRESERVATION.—The Barschall Impregnating Company, 32 Nassau Street, New York, has issued a pamphlet giving a very thorough technical account of the Hasselmann process for the preservation of wood. Among the matter is a paper on the scientific side of the process by Dr. J. E. Weiss, of Freising, Germany; a paper on its practical application by Jos. Berbinhaus, of the royal Bavarian engineers; a paper by Dr. Max Krause on the value of the process for mining timber, and several reports from German laboratories.

PRATT DRILL CHUCK.—To assist in meeting the great demand for their positive driving drill chuck, the Pratt Chuck Company, of Frankfort, N. Y., has found it necessary to install a new 150-hp Corliss engine. The success met with in the sales department has been almost phenomenal, having in addition to the large numbers of orders ahead daily additions. The company attributes the secret of its success to the fact of its chuck permitting the drill to be worn out without slipping or defacing the drill numbers, thus saving much time to the machinist.

LEATHER AND RUBBER CEMENT.—The Major Cement Company, Drexel Building, Philadelphia, manufacturers of cement for leather, rubber and general purposes, directs attention to the many imitation cements on the market made of inferior materials. Mr. Major pays $3.75 a pound for one ingredient in his cement and another ingredients costs $2.65 a gallon. On the other hand a large proportion of the so-called cements and liquid glue upon the market are nothing more than 16-cents a pound glue, dissolved in water or citric acid, and in some cases slightly altered in odor and color by the use of cheap and useless materials. Such cements are practically useless, while the results derived from Major's cement and liquid glue have made it a standard article always to be depended upon.

BATTERY JARS.—The Gilchrist Jar Company, Elmer, N. J., after spending much time and money in perfecting machinery for the purpose, is now making machine-made battery jars, which are claimed to be much superior to the hand-blown jars previously used. Among the advantages are the equal distribution of glass, which assures equal annealing and thus gives a stronger jar. The top of the jar is finished instead of being rough ground, as in the old style. The mouth is absolutely uniform, thus insuring a perfect fit for the closure. There is an absence of all "blow-over" or fine particles of loose glass in the inside of the jar, which faults it is impossible to remedy in the hand-blown jar. Being the only concern in the country which produces machine-made jars, its capacity of 15,000 jars daily is sometimes taxed to its utmost to fill orders.

THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY has secured through its Cleveland office a contract for an increase of power plant for the Sherwin-Williams Company, Cleveland, paint manufacturers. The installation will consist of a 120-kw, two-phase alternator, 7200 alternations, with a speed of 720 r. p. m.; seven Type C induction motors, viz., one 30-hp, three 10-hp, one 2-hp, one 3-hp and one 1-hp. Also a contract for an extension of equipment for the electric plant of the Lorain Steel Company at Lorain, Ohio. This consists of a 300-kw, 500-volt generator, operating at 135 r. p. m. and direct connected to a Buckeye engine. The same company is also furnishing an addition to the Berea, Ohio, municipal lighting plant. This installation consists of a 120-kw generator, operating at 16,000 alternations, and belted to a Buckeye engine.

THE DIEHL MANUFACTURING COMPANY, of Elizabethport, N. J., in a circular letter, calls attention to a recent decision sustaining the validity of its electric fan patents, and enjoining the further use of infringing fans. Notice is given that all past infringers, whether they are users, dealers or manufacturers of fans, who will now save the company the expense of further litigation by agreeing, for the future, to respect its patents, and desist from infringements will, upon communicating with the Diehl Company to that effect, be treated with liberality in the matter of settlement for past infringements. On the other hand, it is stated that parties who force litigation for the protection of its rights must expect to pay the full measure of damages. The patents referred to are ten in number, of which three were issued in 1889, one in 1890, two in 1891, one in 1893, two in 1895, and one in 1897.

SHEAFF & JAASTAD, 85 Water Street, Boston, Mass., have the following plants under construction: A power plant at Medway, Ohio, for the Springfield, Dayton & Urbana Street Railway Company, which will comprise three 300-kw Westinghouse generators, direct-connected to Slater cross-compound engines, and a battery of Babcock & Wilcox boilers. The same company is building an extension for the Portland, Me., Railway Company, and will install a General Electric generator direct-connected to a Rice & Sargent engine. For the Exeter, Hampton & Amesboro Railway Company, at Exeter, N. H., they have just installed a 300-kw General Electric generator direct-connected to a cross-compound Buckeye engine. For the Lexington & Boston Street Railway Company they are constructing a new plant at Lexington, which will include two 300-kw General Electric generators direct-connected to a cross-compound Slater engine.

Record of Electrical Patents.

UNITED STATES PATENTS, ISSUED APRIL 3, 1900.

[Conducted by William A. Rosenbaum, Patent Attorney, Times Bldg., N. Y.]

646,418. MACHINE FOR GENERATING AND UTILIZING STATIC ELECTRICITY; W. Dodd and A. D. Struthers, Des Moines, Iowa. App. filed July 14, 1899. Instead of the usual disks used on a static machine, this invention provides for the use of cylinders, one inside of the other. One of the cylinders carries the brushes while the other carries the generating surface.

646,454. TRACK CIRCUIT CLOSER; S. L. Meeley, Pierron, Ill. App. filed May 10, 1899. A peculiar form of spring placed beside the rail to be depressed by the car wheel and to close a circuit only when the car moves in a certain direction.

646,460. TROLLEY; W. B. Potter, Schenectady, N. Y. App. filed Dec. 14, 1898. The trolley is raised and lowered by means of air pressure under the control of the motorman.

646,467. MOTOR FRAME; S. H. Short, Cleveland, Ohio. App. filed Oct. 15, 1898. The motor frame, gear box and an arm arranged parallel to the gear box and on the opposite side of the frame, are cast in two parts and hinged together, the hinges occurring at one extremity of the arm and at one end of the gear box.

646,485. REVERSING AND CUT-OUT SWITCH; T. von Zweigbergk, Cleveland, Ohio. App. filed Jan. 26, 1897. This is a special form of controller for reversing one or more motors and for cutting out a motor when desired.

646,526. ELECTRIC CONTROLLER; J. C. Lincoln, Cleveland, Ohio. App. filed July 24, 1899. For changing the speed, a motor is provided with a series coil and a shunt coil; the controller is adapted to make connections with a battery for supplying a varying voltage to the armature and series coil and a constant voltage to the shunt coil.

646,573. WIRE CONNECTOR; A. Gartner, Paterson, N. J. App. filed Feb. 8, 1900. This is a "torsion" joint, in which the sleeve, before it is twisted, is indented longitudinally between the overlapping wires to cause the sleeve to hug the wires closely.

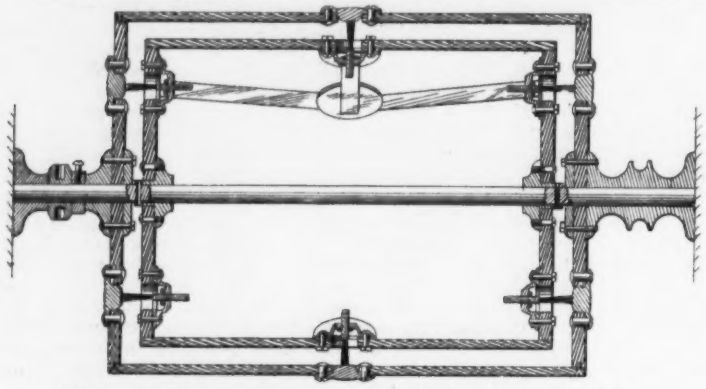
646,598. RELAY; L. Cerebotani, Unich, Germany. App. filed Oct. 14, 1899. The relay consists of two pairs of magnets, the cores of which cross each other, the object being to provide a more sensitive instrument.

646,626. SURFACE CONTACT RAILWAY SYSTEM; G. Paul and H. Wriggers, Augsburg, Germany. App. filed Aug. 11, 1899. This is a system in which the relays which control the sections may be reversed in groups, according to the direction in which the vehicle is desired to move.

646,643. INSTRUMENT FOR MEASURED SERVICE TELEPHONE; C. E. Gierding, West Haven, Conn. App. filed April 4, 1899. The insertion of a key to unlock the instrument informs central office that it is desired to use the instrument and at the same time registers the incident on a counter.

646,701. PLUG SEAT FOR TELEPHONE SWITCHBOARDS; A. K. Keller, Philadelphia, Pa. App. filed May 17, 1899. A metallic socket of special construction is inserted in the face of a table to receive and support the plug while out of use.

646,714. RAILWAY SIGNAL; H. B. Taylor, Newark, N. J. App. filed Nov. 22, 1899. A magnetic friction clutch is arranged to act on the pivotal shaft



646,418.—Machine for Generating and Utilizing Static Electricity.

of the signal arm, and an electric motor actuates the arm itself, the circuit of the motor and clutch being changed at the same time.

646,717. RAILWAY SIGNAL; J. Wayland and H. B. Taylor, Newark, N. J. App. filed Aug. 5, 1899. A modification of the preceding.

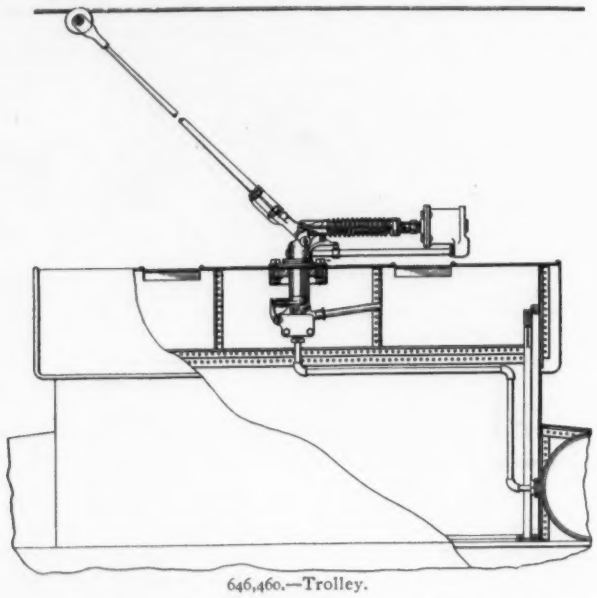
646,718. RAILWAY SIGNAL; J. Wayland and H. B. Taylor, Newark, N. J. App, filed Aug. 5, 1899. A further modification.

646,719. RAILWAY SIGNAL; J. Wayland and H. B. Taylor, Newark, N. J. App. filed Aug. 5, 1899. Another modification of the preceding.

646,721. ELECTRICAL INDICATOR FOR ELEVATORS; W. H. Baker, Central Falls, R. I., and F. E. Kip, Montclair, N. J. App. filed Feb. 2, 1899. Details of apparatus for lighting a lamp as the elevator approaches a landing.

646,742. ELECTRIC BONDS FOR STREET MAINS; A. A. Knudson, Rutherford, N. J. App. filed Dec. 15, 1899. The object of this invention is to confine any stray current that may be flowing along a water or gas main to the pipe itself, and for this purpose a bond is made to connect abutting sections of the pipe, the bond being entirely covered by the joint between the pipe sections.

646,744. BRANCH OR LAMP SWITCH; E. Liedscher, Nuremberg, Ger-



646,460.—Trolley.

many. App. filed Dec. 22, 1899. The spring which creates the snapping action is put under tension by tongues offset from the spring itself and engaging with shoulders on the key.

646,768. CONTROLLING APPARATUS FOR ELECTRIC RAILWAY CARS; A. Sundh, Yonkers, N. Y. App. filed Sept. 25, 1899. This invention embraces appliances for controlling the impelling mechanism of an electrically driven car by means of a manually operating governor on each platform and in combination with such appliances a system of train wires by means of which the impelling mechanism of a multiplicity of such cars coupled together in a continuous train can be simultaneously started or stopped or otherwise synchronously operated from either platform on any one of the cars.

646,793. MEDICAL GALVANIC BATTERY; H. Bentz, New York, N. Y. App. filed Nov. 9, 1899. A large number of cells are placed upon a frame intended to be worn by a person and a switch is arranged to couple up the cells in various ways.

646,839. SERVICE SWITCH FOR ELECTRIC LIGHTING SYSTEM; G. O. Kelley, Cambridge, Mass. App. filed Nov. 20, 1899. The cover of the box enclosing the various switches is made in sections, each of which carries fuse connections. One section can be removed and the fuse adjusted without interfering with the others.

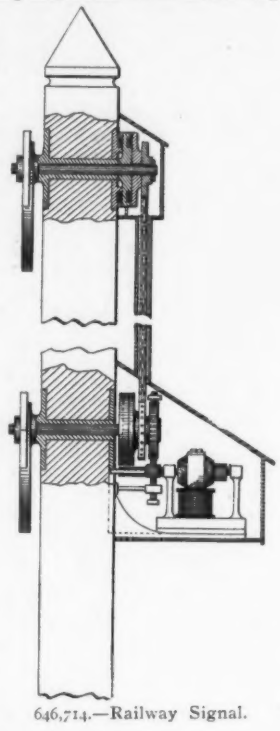
646,883. ELECTRIC ARC LAMP; P. H. F. Spies, Yonkers, N. Y. App. filed Nov. 1, 1899. The invention consists of a peculiar mechanical relation between a choking coil and the carbon regulating mechanism of an alternating current lamp.

646,886. ELECTRIC SIGNALING DEVICE FOR HYDRAULIC HOSE; B. L. Stowe and J. J. Voorhees, Jersey City, N. J. App. filed Nov. 9, 1899. An electrical conductor for carrying signal currents is imbedded between the layers of the hose.

646,887. ELECTRIC SIGNALING DEVICE FOR HYDRAULIC HOSE; B. L. Stowe and J. J. Voorhees, Jersey City, N. J. App. filed Nov. 15, 1899. A modification of the preceding.

646,889. CONTROLLER FOR ELECTRIC RAILWAY CARS; A. Sundh, Yonkers, N. Y. App. filed Dec. 23, 1899. An extension of the system described in patent 646,768.

646,911. ELECTRIC HEATER; G. S. Knox, Philadelphia, Pa. App. filed Jan. 30, 1899. This is a water heater in which the wire resistance is located outside of a series of tubes through which the water flows. The electric switch and the water valve are connected together so that both can be operated at the same time.



646,714.—Railway Signal.

646,675-76-77-78-79-81-82-83. TELEPHONE EXCHANGE SYSTEM; Edward E. Clement, of Washington, D. C. Apps. filed June 16, Aug. 20, Dec. 24, 1898, and April 21, 1899.

646,680-94-95. TELEPHONE EXCHANGE SYSTEM; Edward E. Clement, of Washington, D. C., and William D. Gharky, of Philadelphia, Pa. Apps. filed Aug. 20 and Dec. 24, 1898.

646,688-89-90-91-92-93-96-97. TELEPHONE EXCHANGE SYSTEM; William D. Gharky, of Philadelphia, Pa. Apps. filed July 2, 1895; July 1, 1897; April 1, June 16, 1898; April 21, May 17, 1899.

646,922. STORAGE BATTERY; Elmer A. Sperry, of Cleveland, Ohio. App. filed Oct. 19, 1898. (See Current News and Notes.)

646,923. CELLULOSE ENVELOPE FOR ELEMENTS OF STORAGE BATTERIES; Elmer A. Sperry, of Cleveland, Ohio. App. filed Oct. 7, 1899. (See Current News and Notes.)

646,894. STORAGE CELL; Henry J. Cogswell, of Hartford, Conn. App. filed Feb. 5, 1900. (See Current News and Notes.)

646,552. STORAGE BATTERY; George Weltden Gesner, of New York. App. filed Dec. 18, 1899. (See Current News and Notes.)

646,858. VACUUM TUBE LIGHT; Daniel McFarlan Moore, of Newark, N. J. App. filed April 21, 1899. A vacuum tube is coated extensively at its ends with graphite paste, to which the circuit terminals are secured.

646,476. CARBON BRUSH; Elihu Thomson, of Swampscott, Mass. App filed May 5, 1897. (See Current News and Notes.)

646,500. ELECTRIC TRANSFORMER; Walter S. Moody, of Schenectady, N. Y. App. filed Aug. 27, 1897. (See Current News and Notes.)

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[In Charge of Dr. Ralph Julian Sachers, 120 Liberty Street, New York.]

107,673. ELECTRIC RAILROAD; Union Electricitäts Gesellschaft, Berlin. App. filed April 8, 1899. Any desired point of a rail of a railway system is connected by an independent insulated cable to one pole of the station generator; the cable is also connected to the station end of the same rail and a motor placed in this connection, so that part of the return current must pass through this motor. The motor produces a counter-electromotive force which, by suitable field excitation, may be made about equal to the voltage-drop in the insulated cables. The mechanical energy of the motor may be used for any suitable purpose.

107,682. INDUCTION METER FOR THREE-PHASE CURRENT; Carl Raab, Kaiserslautern. App. filed Feb. 8, 1899. A shunt coil co-operates with each main coil in two leads. A second shunt coil co-operates with the main coil in the third lead and is connected to one of the terminals of the first shunt coil. The same terminal is connected to the first lead by means of an adjustable choke coil. This choke coil can be set in such a way that in the first shunt coil a current is produced in quadrature with the e. m. f. in the first two leads; and in the second shunt coil a current in phase with the e. m. f.

108,579. ELECTRIC CONDUCTOR; E. Falkner-Rumpf, Basel. App. filed Aug. 2, 1898. The pulverized substance, such as carbon, forming the conducting body, is intimately mixed with a tar-like binder, to which are added 25 per cent. water and such organic substances which have a certain affinity to the water as well as to the tar, as creosote or gelatine.